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ANNOUNCEMENTS.

FEILDEN'S MAGAZINE is published at the *beginning* of every month.

In consequence of the large number of pages to be prepared and passed for press, the careful nature of the printing required for high-class production, the advance arrangements made for extensive circulation, and in order to facilitate departmental business, observance of the following rules is necessary:—

Literary Matter to reach the offices not later than the 15th of the month (as much earlier as possible) previous to date of publication. Communications to be addressed "Editorial Department."

Advertisements intended for insertion in next issue must be received not later than the 15th of the month (as much earlier as possible), to insure correct classification. All communications respecting same to be marked "Business Department." Advertising Rates, on application, regulated according to positions available.

Subscriptions and letters with reference to copies to be marked "Subscription Department."

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For Buyers' Guide, Index to Advertisers, and Directory of leading British Manufacturers, see pages ii. and iv. of second cover, and pages iii. to xiv. (in first part of Magazine).

All communications to be addressed
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THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

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A Brief Retrospect.

READERS of FEILDEN'S MAGAZINE will have noted the vigorous action this Magazine has taken on various occasions, on questions affecting the public interests. The policy we have carried out has from the first been in strict accordance with the distinguishing motto of the journal, and we have the best authority for stating that it has proved in every way acceptable to our many supporters.

It is true that we have been compelled to endure the penalty which always awaits those who may in any way distinguish themselves beyond their compeers. We have been accused of being young. A weekly contemporary, in a leading article of great solemnity of tone, charges us, in addition to this fault, with being addicted to the "new journalism." The mental perturbation caused by these and other attacks was readily dissipated by a glance over the advertising pages of this journal, in singular contrast for the most part with the meagre appearance of its detractors. But anything like malice is not in our composition, and if it is any consolation to our adversaries we will cheerfully admit the justice of the two main allegations made against us. We *are* young—temporarily, and we *are* attached to the "new journalism." Our interpretation of this phrase, however, would probably be different to that placed upon it by *Commercial Intelligence*. We contend, and our readers seem to agree with us, that it is possible to publish a journal that shall effectually represent the highest interests of its country—her arts, her manufactures and commerce—whose contents shall be interesting as well as instructive; not a mere chronicle of events, but a journal capable of taking a live and active part in affairs which come within its purview.

In this respect, FEILDEN'S MAGAZINE has been concerned with several matters that have aroused very wide-spread attention. The first of these was the position of the British Section at the Paris Exhibition, and the manner in which the spaces had been allotted by the officials representing the Royal Commission. It will be remembered that our statements were denied by the Secretary of the Commission, but never confuted. Public attention was directed to the matter, and steps taken by the Commission to rectify, so far as possible, the faults we pointed out. In spite of the efforts made by the Commission, it is, however, a regrettable fact that in many departments—notably that of electricity—the British Section will not in any way be truly representative of the nation. While upon this subject, we may be excused for noticing the disingenuous attempts of one or two of our contemporaries to fix upon us the responsibility of the attempted "boycott" of the Exhibition, which came to such a futile conclusion. It is true that some of the daily press, both in London and the provinces, quoted information from FEILDEN'S MAGAZINE in articles referring to the "boycott"; but so far from encouraging the movement, we did precisely the reverse. Our sentiments on the matter were expressed in our issue of September last; and these were widely copied and commented on in terms of approval by several newspapers in Paris and elsewhere.

About six months ago, we felt it our duty to direct attention to a very important matter affecting the export interests of this country: that is to say, the Government Trade Consular Reports. We are bound to acknowledge that the attitude we took up on this question became the subject of much controversy, and aroused a certain amount of feeling. Inasmuch as a settlement of the matter has been arrived at for the time by the establishment of a Commercial Department of the Board of Trade, it is not necessary to re-open the matter at present. We may point out, however, that in spite of the criticisms upon us made by the *Financial Times* and other newspapers, the programme of the Commercial Department covers to a very large extent the recommendations made by us before its establishment was decided on, or at least publicly known. With reference to those organs which have published anonymous communications professing to come from Consuls decrying our criticisms, let us say that we have communicated with every Consul-General, Consul, and Vice-Consul representing the

British nation in the world. We have in turn been in receipt of communications from at least nine-tenths of those whom we have addressed. With exceptions, whose numerical value falls below ten, our criticisms have been either wholly or partially accepted by those in a position to best appreciate their justice.

We are justified, we contend, in believing that in thus opening up this question —that of the unpractical character, unreliability and infrequent publication of the Consular Trade Reports—and in stirring up an interest on the matter among the Consuls themselves, we have been successful in accomplishing something that will prove of value to the export trade of the country. No other object than this inspired our action, and we are thoroughly satisfied with the results of our exertions.

We conclude this short summary by a reference to two matters which afford us, as we submit, legitimate cause for a little self-gratulation.

Most of our readers will recall an article that appeared in our December issue last year, in which attention was called to the anomalous position of the British Patent Office. We showed that this institution was making a profit of over a hundred per cent.—the exact figures were, revenue £223,419; expenses £99,057—out of inventors, proverbially a needy class of the community. This article was reprinted or commented upon by, as nearly as we can judge by the extracts sent on to us, eighty-seven leading papers of this country besides other periodical publications. The opinion expressed was unanimous. At the time of writing, six weeks after, the result lies before us in the following paragraph furnished by the Press Association:

> "We learn from the Press Association that Mr. Ritchie, the President of the Board of Trade, has appointed a Departmental Committee upon the subject of patent facilities, and that the following are the official terms of the reference: "To consider various suggestions which have been made for developing the benefits afforded by the Patent Office to inventors, and report." The committee will comprise Mr. F. J. S. Hopwood, chairman; Mr. Edward Carpmael, President of the Chartered Institute of Patent Agents; Mr. C. N. Dalton, C.B., Controller-General of Patents; Mr. J. A. Kempe, deputy-chairman of the Board of Customs; Mr. S. E. Spring Rice, C.B., of H.M. Treasury; and Mr. Arthur Neeves, of the Board of Trade, who will act as secretary."

With regard to another question—the establishment of a School of Chinese which we have urged, the letter herewith which, at the request of the author, we are pleased to publish, speaks for itself:—

> "With regard to your article in a recent number of your Magazine in which you urge the importance of commercial schools in this country for teaching Chinese, with a view to equipping young men—who propose to make their career in the Far East—it may instruct your readers to know that such a school is about to be formed in the City of London under the auspices of the China Association. Proficient native teachers are being engaged in China, and as soon as they arrive the school will be opened, probably about the end of April.
>
> "The leading merchants and others interested in China have subscribed to a fund guaranteed for five years, but further subscriptions or donations would be gladly received with a view to giving greater permanency to the institution. I enclose a memo. prepared by Mr. Grundy, Hon. Sec. to the China Association, setting out the aims and objects of the promoters, and I should be glad if you could find space in your valuable Magazine to give it further publicity; due notice will be given to the public by advertisement as soon as we are in a position to accept pupils. Meantime, further information can be obtained either at the China Association's rooms, 159, Cannon Street, or from the undersigned,—
>
> "G. JAMIESON
> "(Ex-Consul-General, Shanghai).
> "January 6th, 1900,
> "10, Astwood Road,
> "South Kensington, S.W."

The record of FEILDEN'S MAGAZINE—an earnest and aggressive supporter of British trade interests—is but a short one in the sense of time. But although its age is not great, FEILDEN'S MAGAZINE has made its influence felt in a manner never remotely attained by many far older publications. Our objects are known to and have received the approval of our supporters, and we shall carry them out with all the enterprise and all the vigour at our command. We trust that in the future, as in the past, we shall continue to receive the approbation of our readers, which will inspire us to renewed efforts to render FEILDEN'S MAGAZINE, in the highest sense, a representative organ of a great nation's industries.

The Keynote of the Future.

In a leading article in our last issue, we laid great stress upon the fact that the representatives of German and American firms were actively engaged following the war operations on the spot in South Africa, and making all necessary preparations to supply the new work required by damaged railroads, bridges, &c. We furthermore asserted, in an earnest exhortation, that we knew of no British firms who were acting in a similarly enterprising manner.

Since the publication of this article we have been supplied with information which we are only too glad to place on record. British engineering establishments have risen to the occasion, and have evidently determined that the Atbara Bridge affair shall not find its parallel in South Africa. As a result, a contract which will become historic has been secured in competition by one of our leading houses, and the building of the new bridge across the Tugela, the first span of which has been executed in half the time allotted to it by the authorities, is an achievement of which Englishmen may well be proud. We believe we are right in saying that in this not only a British but a world's record has been established.

We look with the greatest possible satisfaction upon this accomplishment; it is exhilarating and inspiriting, and goes to prove that the apologists for the sending out of large orders from this country to foreign manufacturers were wrong, and the aspersions which have been cast upon our resourcefulness and skill by certain agents of foreign firms are so much tarradiddle and jealous talk, but for all that not the less injurious. Still, we cannot help saying that the British manufacturer is himself largely to blame, apart altogether from official muddling, for the loss of many fine contracts over sea, and we deprecate the short-sighted attitude adopted by the heads of many wealthy British establishments who, when the matter of the passing of certain work to competitors is brought forcibly to their notice, merely shrug their shoulders with supreme indifference. The feeling seems to be pretty deeply rooted in the minds of many of Britain's wealthy and successful manufacturing engineers that in consequence of the standard of excellence which has always characterised their work—their name being the hall-mark for genuineness, and their works being in such a prosperous condition—they can afford to let the foreign manufacturer have a few of the contracts which they are unwilling or unable at the time to undertake from causes best known to themselves. In this connection it would be well to remember Shakespeare's immortal words—

"A little fire is quickly trodden out,
Which, being suffered, rivers cannot quench."

It is the insertion of the *thin* end of the wedge of foreign competition in our commercial and manufacturing domain that we have mostly to fear. Every business man knows that it is often difficult enough to make an effective start, but such a start once made it is equally as difficult, providing the right thing is done, to be shaken off. Another matter surprises us. It is notorious that even when our manufacturers obtain and execute colossal contracts their modesty is astonishing. They take it as a matter of course. Whilst this spirit can be admired, it having all the true British ring of faith in one's abilities and independence of action, as a principle it is to be condemned. When Great Britain stood alone as the manufacturing nation of the world, when Germany was a comparatively feeble State—and what few ships she had were chiefly purchased in England—when France had no experience of motor-car building, when the fabrication of electrical specialties was unknown to the Swiss workman, when the United States of America gave almost all her orders to the Old Country—before the emigration of skilled British artisans to her shores, which formed the basis of her great manufacturing and inventive capacity—*then* the policy of indifference was one we could readily afford to assume. We had no one against us; the workshop of the world practically commanded the trade of the universe, and the growing nations

looked on jealously and, perforce, admiringly; they *had* to come to us. Now a change has come across the scene: Germany is in the field as a competitor of Britain in every line of commerce and manufacture; Russia is seeking, by all the means in her power, to extend her trade; France is making the most strenuous endeavours to increase the number of her commerce destroyers; Switzerland is supplying British works with dynamos and other goods; in fact, an aggressive fight is going on in every part of the civilised world to oust Great Britain from her premier position. This competition is increasing in volume and intensity year by year, month by month, and *not even the most powerful firm of this powerful land can afford to lose a contract which could and should be retained.* If works are not large enough, our princely manufacturers have money enough to extend them. To remain where we are is to go back; we *must* expand judiciously according to our growing requirements, and give our workmen better and more wholesome surroundings to fit them physically and mentally for the fierce race of industrial progress. Many firms are, we know, to-day doing this, and they are to be commended for their sagacity; they will reap the benefit hereafter. Others are stagnating their ultimate resources and stultifying their future by an opposite policy. They perhaps fear the slack time which must inevitably ensue after a few years of abnormal activity. We do not advocate wholesale and sweeping changes in frantic haste and without counting the cost, but the British manufacturer has only himself to blame if he does not make adequate preparations for a continuously busy time, and adopt those measures to *remain* busy which are open to him by judicious methods of pushing his business and keeping his name and specialties before the buyers and contractors of the world's markets.

Articles of great interest by leading experts will appear in the March and subsequent early issues on the following subjects:—

The Balloon as a War Machine.
Defects in Recent Types of Cargo Ships.
Depreciation of Machinery.
The Making of a Glow Lamp.

British and American Shipbuilding Industry.

The past year closed with a larger new tonnage to the credit of British shipbuilding than has hitherto ever fallen to its lot in history. Altogether 2,393,625 tons represents the shipping launched during 1899 from the private and Government yards of this country. War vessels took 286,144 tons, so that the 2,107,481 tons is the commercial work accomplished on behalf of British and Foreign shipowners.

Every sign points to a continuance through the present year of the phenomenal activity which characterised the last. Shipbuilders have been increasing their yards and adding to their machinery, and of this we have yet to see the full effect.

Foremost among the shipbuilders is the great firm of Harland & Wolff, who built only seven ships. These, however, were leviathans, their united dimensions amounting altogether to the total of 82,634 tons, the average displacement being 11,805. Last year there was launched from the Belfast shipyard the vessel that was to restore to us the supremacy of the seas—so far as individual size was concerned—taken away from us temporarily by the German boat, *Kaiser Wilhelm der Grosse.* The *Oceanic* is the largest ship that has ever floated, with her 17,274 tons; but our credit is but partially returned to us, since the *Oceanic* is not able to compete in speed with her foreign rivals, who may justly vaunt the possession of the fastest passenger liner in existence.

Although the shipbuilding industry has with us been intensely busy, the fact must not be overlooked that both our rivals, Germany and the United States, have also had their resources taxed in almost an equal degree. Both countries, though on a scale immeasurably inferior to our own, have been unprecedentedly active in shipbuilding. Though we have no serious apprehension of competition from Germany for at least a number of years to come, this situation does not apply to the United States, whose doings, present and prospective, are calculated to excite serious

uneasiness, though we think the importance of the effect of the legislation threatened in America may easily be exaggerated. It is the fact, however, that with the growth of American export trade, which is increasing, and which will no doubt continue to increase, there is a cry throughout the country for an American mercantile marine. It is declared that British freights constitute a clog on the advance of American exports, and Government subsidies on a large scale are called for to bring an American mercantile fleet into being. This is no idle menace, but a programme seriously intended, and no effort will be spared to carry it out. Should the United States Government undertake the task which is asked of it, the prospect is hardly one which our shipowners can be expected to view with equanimity.

With regard to the subject of competition in actual shipbuilding, such a possibility at least in the immediate future may be disregarded. In the business of building ships there are two main factors to be considered: skill and cost. Granting that the Americans could compete with us on the first point, which is a doubtful one, they could not, under the industrial conditions that now exist, and which may be expected to endure for a long time, hope to attain a level with ourselves as to the cost of material. It is true the opinion has been expressed, we think by the irrepressible Mr. Andrew Carnegie, that it only needs the "right man" to start to "beat the English shipbuilders." As Mr. Carnegie has already consigned British industries as a whole to prospective destruction, the effacement of the British shipbuilding industry is necessarily only a part of his complete programme. As a matter of fact, as the position now stands, it is impossible for an American shipbuilding yard to compete successfully in any class of vessel with an English one.

The question then arises as to the legislative measures now being discussed, and which have for their object the forcing of an American national shipbuilding industry. That such is an economic possibility is a proposition that finds assenters and dissenters. No doubt such an industry could be established in the artificial manner designated. State encouragement is merely protection driven to a logical extreme. We have seen protection build up a tin-plate industry in the United States; we have seen State aid establish and maintain sugar industries in Germany and France. Yet, though the McKinley tariff brought into being and fostered the tin-plate industry, as did the bounties the sugar manufactures of the Continent, the most ardent supporter of either one or the other will confess that the gross results are not entirely satisfactory. That the McKinley tariff was a killing blow to our Welsh tin-plate mills must be acknowledged. They found themselves deprived, after but a short period, of their chief customer. British tin-plate exports dropped year by year, and dwindled to but a fraction of their former totals. Now, however, the Welsh tin-plate industry is recovering, and appears destined to assume even a greater position than it occupied before. Their exports have simply changed their direction, and instead of going to the United States are going somewhere else; the American citizen meanwhile having the satisfaction of paying an artificial price for his home-produced article. The sugar bounties, too, will shortly be discontinued, it being at last popularly recognised that these bounties are simply gifts out of the national purse to foreign consumers.

A forced American shipbuilding industry would necessarily be subject to the draw backs which experience has shown to be inseparably associated with industrial culture of the hot-house kind. A State-aided industry is a plant that will droop and decay when taken out of its artificial atmosphere. It is a nurse-child that never grows up; a never-ceasing perpetual drain on the source of its existence.

Submarine Navigation.

PREMONITORY symptoms are not wanting of a possible revolution in naval warfare by the advent of the submarine torpedo-boat. Experiments thereupon have been made in this country at various times,

though never with particularly satisfactory results, and the opinion of our naval experts seems always to have been that the encouragement of invention in relation to such craft was not to be desired. As a nation we are somewhat slow to accept innovations of any kind. Whether we are entirely wise in relegating the submarine vessel to the domain of the sensational novelist is a point open to discussion. Few of the inventions which have helped to make the nineteenth century memorable in the history of the world have escaped ridicule and hostile criticism. It is our opinion, therefore, that we should be manifestly neglecting one of the fundamental principles which justify our place in the literature of the day, if we failed to direct serious attention to the action of other countries in respect of submarine navigation. In spite of past failures, both the French and the American Governments continue to persevere in their investigations. The French Government have lately been experimenting with the *Narval*, a vessel of recent construction, having a displacement of 160 tons, and being driven by a Forest oil engine. As to speed, it is hoped that the *Narval* will develop about 12 knots at the surface and 8 knots when submerged. Travelling on the water at the rate of 12 knots, the boat ought to be capable of covering over 250 miles, and under water at the rate of 8 knots, about 25 miles. So far none of the optimistic accounts made public have been substantiated by the actual facts. Some trouble has arisen in connection with the mechanism, and M. Laubeuf, the designer, is now elaborating improvements which will form the subject of further tests. Very likely the joyful anticipations expressed by part of the French press as to the future destruction of the British navy by submarine torpedo-boats, are not in a way to be realised for a long time to come, but we can afford to run no risks in the future, as we have done in the past, by closing our eyes and ridiculing danger until presently it stands at our very gates. Not only are our neighbours busy, but so also are our cousins and friends across the Atlantic. An official trial board, composed of United States naval officers, has within the last few weeks watched the progress of submarine navigation, as typified by the Holland torpedo-boat. So far, the degree of success attained seems to indicate the advent of a new era in the evolution of submarine vessels. On several occasions the Holland boat was under water for periods of more than 20 minutes, during which evidence was given of her ability to sink beneath the surface, to approach a ship, to discharge a torpedo, to execute evolutions, and to return to a place of safety. Since the recent trials the Holland boat has received renewed attention from several foreign naval *attachés* stationed in the United States, and there is no doubt that their respective Governments are watching the progress of events with the keenness usually displayed under similar circumstances. A Congressional appropriation has already been made for the construction of additional submarine boats, but these will not actually be put in hand until the Navy Department are satisfied as to the most satisfactory design for adoption. No doubt submarine vessels are not even at the present moment without defects—neither is anything else in this world. If it were proper that our Government should decline to make use of any and every invention until it had reached a state of absolute perfection, we should be without national defences entirely. As the position stands, it is perfectly clear that other nations are taking active measures for the provision of submarine torpedo-boats, which, although faulty, might be capable of inflicting serious damage to an opponent in case of war. Some day our costly battleships may be exposed to attack from hidden foes, and our responsible officials will then make the customary prodigious efforts to place the national armaments on a footing equal with that of our opponents. Constant innovations are, no doubt, calculated to upset the happy tranquillity of any comfortable Government department. If it must be upset, then let it be. The British nation cannot always be listening to the same refrain—"Too late!"

Central Heat and Power Stations.

A MONTH or two ago the hope was expressed by Sir Douglas Fox that some day the distribution of heat and power might be effected to the inhabitants of towns and cities from central stations situated at a distance from the places supplied. This suggestion was one amongst others intended to indicate in what manner the healthfulness of our large centres of population might be improved in years to come. There is nothing particularly new in the idea, for it has already been realised in the United States, where steam installations are established for the provision of power, and for the warming of houses in many cities and towns. America, as we all know, is a large country where Nature has provided everything on a grand scale, and where the inhabitants try to live up to the natural advantages of their land. Certain it is that steam installations have been inaugurated there on a scale of magnitude never successfully attempted elsewhere, and the supply of steam to cities from central batteries has become an accomplished fact. Experiments verified by practical results obtained in several cities show that the most economical pressures are between 40 lbs. and 60 lbs. per square inch. Owing to the precautions taken, condensation does not exceed 2·6 per cent. per mile in 3-inch pipes, whilst in 6-inch pipes it is only about 2 per cent. The largest mains in general use are of 8 inches diameter. The experience of Detroit demonstrates the fact that 60 lbs. pressure can be maintained in mains of 10-inch and 6-inch pipe 4 miles long, against drafts for power and heat along the line. Lap-welded wrought-iron steam tubing is employed for the conveyance of steam, and the pipes are lagged in a most complete and elaborate manner. The following is a brief description of the method pursued by Mr. Holly, an engineer who has had large practice in connection with installations of this kind. The pipe is placed in a lathe and wound about, first with asbestos, followed by hair-felting, porous paper and manilla paper; finally, thin strips of wood are laid on lengthwise, and the whole fastened together with copper wire wound spirally over all. The pipe thus cased is thrust into a wooden log, bored to receive it in such a way that an intervening air space will be left between the pipe and the wood, and the log is of such size as to provide a wood covering from 3 inches to 5 inches thick. The elasticity of the wrappings permits free expansion and contraction of the pipe irrespective of the wood log, which is securely anchored to the pipe. The whole arrangement is then placed in a trench a short distance below the surface without regard to the effects of frost. At the bottom of the trench are laid earthen tiles to carry off the earth moisture; and in order further to ensure the continued dryness of the sheath, planks about 1½ inch thick are fastened around the wood log, leaving an air space, and the whole is then daubed with tar and covered in with earth. Pipes prepared and fitted in this manner lose very little heat by radiation, and considering the complex nature of the lagging, this result is not entirely surprising. A well-attested experiment by Mr. Holly shows, as a matter of fact, that the loss is even less than might be imagined. In the case referred to, a line of 3-inch pipe, length 1600 feet, was laid on a descending gradient of 20 feet, the lower end of the pipe being connected with a steam-trap. Steam pressure was constant at 20 lbs. during 12 hours, and water condensed per hour was found to weigh 82 lbs. The boilers evaporated 9 lbs. of water per pound of coal, and the loss caused by condensation did not exceed 2·5 per cent. Expansion and contraction are provided for by junction and service boxes placed at convenient intervals along the line. From the junction-boxes steam passes regulators and meters before entering the consumers' premises.

In England, public installations of gas-water, electricity, and hydraulic power are already in operation, and there seems no reason why the public supply of steam should not also be adopted. A reduction in the number of independent furnaces could not fail to exercise a beneficial effect upon the atmospheric condition of our large cities and towns.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—Rt. Hon. Lord Charles Beresford, C.B.

Incandescent Gas Lighting . . .

In common with many others, we had thought that the expiration of Dr. Auer von Welsbach's patent for incandescent gas lighting, No. 15,286 of 1885, would exercise an appreciable effect on the important industry which has grown up in this form of illumination during the past six years. Upon inquiry, however, we found the lapse of this patent, though much commented on at the time, would not have any effect whatever on the monopoly the present Welsbach Incandescent Gas Lighting Company have fought so strenuously, and on the whole, so successfully to maintain.

The patent of 1885, whose maturing has aroused so much speculation, was indeed commercially valueless. The mantles made under it had neither the lighting efficiency nor the duration sufficient to give them any practical value. True, the 1885 may in a sense be termed the origin of the incandescent gas industry. It would have perished, however, if it had not been re-inforced by later discoveries. As a matter of fact, so long as the Incandescent Gas Light Company was only able to make mantles under the 1885 and 1886 patents, the business done by them was almost nothing, seeing the public would not buy a means of illumination that was on all sides discredited, and the financial results to the company were most disastrous. But just at that period when the Company was almost moribund Dr. Auer von Welsbach produced his thorium-cerium mantle, an invention which completely revolutionised the situation. The position was completely changed on the introduction of this mantle, and incandescent gas lighting obtained a hold on the public which has been maintained and developing ever since.

The patent of 1893 is the patent under which the Welsbach Incandescent Gas Light Company are now working; and the mantle produced under this patent is the only mantle which, up to the present, possesses any commercial value. This is proven by the fact that every infringement which the Company have had to deal with has been an infringement of the 1893 patent. The monopoly of the Welsbach Company therefore will continue to exist until the year 1907.

With regard to this point we have noted in the *Journal of Gas Lighting* for December the 26th last year, a report of the judgment delivered by the Court of Appeal in the case of the Welsbach Incandescent Gas Light Company, Ltd., against the Daylight Incandescent Mantle Company, Ltd. This judgment reversed a decision in favour of the Welsbach Company, but this adverse judgment was probably welcomed by the plaintiff Company for the interpretation placed by Lord Justice Romer, and concurred in by the Master of the Rolls, on the 1893 patent, which was referred to as embodying "a remarkable and astonishing discovery."

This, then, is the mantle which has made the fortunes of the Welsbach Company, and whose patent they have been engaged in defending against successive infringements ever since its introduction.

Fog Signals . . .

ONE of the most urgent questions of the day in connection with railway work is presented by the fog-signalling problem. The nature of the system at present adopted by railway companies appears less indicative of a problem than of a theorem, although its actual value is at times decidedly "problematical." We need not exhume by-gone records as the justification for this view, because recent events unfortunately afford a sufficient demonstration. Two collisions in London, on the South-Eastern Railway, show the general inefficiency of existing arrangements which, as Sir William Preece said in our August issue, are "barbarous, dangerous and irregular." The Spa Road collision, on the London, Brighton, and South Coast Railway, was attributed by the Coroner's jury to the negligence of the engine-driver. In his evidence, however, the driver said that he was unable to see the signals properly by reason of fog and steam, and there were, as the signalman stated, no fogmen out because he thought them to be unnecessary. Here we have an arrangement which apparently makes the lives and safety of passengers dependent upon the signalman's sense of proportion, whilst the driver who has to see the signals is in no way consulted. Again, with regard to the Wivelsfield accident, although the driver was undoubtedly to blame, there are some circumstances recorded which emphasize objections to present methods of fog-signalling. The driver relied upon fogmen being out "as the fog had been on for three hours," and thinking the line clear he did not stop the train. If a scientific system had been in use there would have been no thinking about the matter, he would have known the facts. Further, it was elicited that sudden illness prevented an all-important fogman from being at his post, and the provision of a substitute did not completely devolve on any one official, although three servants of the company appear to have been partially responsible. The stations and signal-boxes at Wivelsfield and Burgess Hill were undoubtedly understaffed, and the signalman at the former place possessed no instrument for hand-signalling beyond a red lamp, which he "waved frantically" out of his box, only 200 yards from the point of collision. All manifestations of uncertainty and of human error at critical times would at once be eliminated by the adoption of some system establishing direct communication between signalmen and drivers. Before this desirable consummation can be arrived at, two things are necessary, (1) the invention of the system, and (2) its acceptance by the railway companies. Needless to say, many ideas have been patented for "fog and audible signals," but few of them are worth serious consideration. There are two systems, however, which might replace the entire paraphernalia at present used, in the adoption of one of which there would be one uniform mode of signalling, available for day and night in all weathers. Results furnished by practical tests on the Great Northern Railway have been of a highly satisfactory nature, and there is no doubt that the inventions are well worthy of the most serious consideration on the part of our railway authorities. We think it very desirable that the whole question of fog-signalling should be reviewed without delay, and we should be glad to hear of some combined action having for its object the removal of a fertile source of danger to the public and of expense to the companies themselves.

The British Traction Engine . . .

AMONGST other phenomena indicative of the wonderful foresight and energy displayed by the War Office, we notice the recent despatch of traction engines to South Africa. The employment of these rapidly moving vehicles was not decided upon until careful tests had been conducted at Aldershot, possibly for fear that their high rate of speed might prove to be out of all proportion to the exigencies of modern warfare. Apparently the vehicles in question came through the ordeal in a satisfactory manner, for we now find them to be in actual operation at the theatre of war.

People are not wanting who suggest

that traction engines are entirely too slow and cumbersome, and that steam motor vans protected by armour plate if required, would be in every way preferable for many military purposes, as possessing far greater speed and endurance. Whether this view be correct, it is not our province to decide, but we may with advantage present some brief memoranda as to what are the views of ignorant and benighted foreigners with regard to motor transport.

Commencing with the Boers, who according to Lord Wolseley are the most ignorant of all people, we observe the question has been carefully considered, and that two motors are already in use. Experiments have shewn that none but crack riflemen can hope to hit a rapidly moving motor-van, except by chance or at short range; that such a vehicle requires very little nourishment as compared with horses developing equal power; and that on ordinary roads speeds may be attained, varying from 15 to 30 miles an hour. Believing these results to indicate the advantages of motor transport, the Boers ordered more vehicles from Germany and a number of motor-cycles from France. The former have not been delivered, but the latter have, and are probably being used for scouting and despatch work.

The French, German and Austrian Governments have all taken steps with a view to the introduction of motor-transport, and in this movement the Germans are particularly active, having produced a troop wagon for rapid service capable of travelling 40 kilometres an hour. Some trials, conducted by order of the Emperor, have recently been made in the Hartz district, where baggage wagons loaded up to 2¼ tons had to travel along steep mountain roads, and also over stony field roads and ploughed land for long distances. Four vans, two heavily loaded with passengers and two with baggage, crossed the Brocken from Quedlinburg, breaking the record of the Brocken Railway, and reaching Berlin on the second day. These vans were all actuated by benzine motors, and were similar in type to motor vehicles used in Berlin.

According to the views held by our own authorities, it would appear that every foreign nation suffers more or less from a chronic and unholy desire for something quick in relation to warfare. Once it was for quick-firing rifles, then for quick-firing cannon, and now it is for rapid transport. Why will these restless people persist in disturbing the restful energy which is centred in Pall Mall?

New Process for Extracting Iron from the Ore . . .

A GREAT number of experiments have been made since Dudley, about the year 1620, first introduced smelting with coal; when Abraham Darby, of Coalbrookdale, first made experiments in smelting with coke; and when Mr. James B. Nielson invented the hot-blast for furnaces, in the year 1828. In this country, on the Continent, and in the United States of America, different processes for extracting the iron from the ore so as to obtain it at a cheaper rate than heretofore have been devised, in most cases proving a complete failure, chiefly on account of the inferior quality of the iron obtained. In many instances, it has been found that, although experimentally it appeared as if the product ought to have been cheaper, in actual practice it was found to be more costly than the older methods of using the blast furnaces.

At the present moment a great interest is being taken in Sweden in a new process for extracting the iron from the ore by means of electricity. This is a very important subject in a country like Sweden, on account of the high price of coal and coke, and where, up to the present time, most of the iron smelting has been carried on by means of charcoal. Mr. de Lavall, of steam turbine and cream separator fame, is now experimenting with a new process of his own, by means of which he hopes to be able to extract the iron from the ore by electricity at a very cheap rate, so that the Swedish iron masters will be able to compete with any other class of iron, both as regards

price and quality. If Mr. de Lavall succeeds it will no doubt give a great impetus to the Swedish iron trade, and many iron masters in North and Central Sweden are anxiously watching the progress of the experiments. It may be said that electricity is expensive, but in most parts of Sweden water is plentiful, hence, the dynamos can be actuated cheaply.

We hope to be able shortly to give a full account of the experiments, together with the results obtained.

Combined Refuse Destructors and Power Plants . . .

MUNICIPAL engineers will do well to digest the facts laid before them by Mr. C. Newton Russell, in his paper read before the Institute of Civil Engineers. The results which he has published were obtained from eight combined plants in England and two abroad, and the Shoreditch plant was specially dealt with. The average calorific value of the refuse is fairly high, being ·99 lbs. of water per pound of refuse, so that its value, weight for weight, may be said to be about one-ninth that of coal. The average cost of burning the refuse, including furnacemen, yardmen, repairs, etc., was *2s. 6·9d.* per ton. As the simple removal of dust from a London district in barges, etc., is not less than *2s. 6d.* per ton, this cost of burning must be considered very low. The highest recorded temperature in the furnace was 2,500° Fah., and the average about 1,500° Fah. As the ordinary furnace where coal is burned has a temperature of about 2,500° Fah., the temperature of the burning refuse may be considered good for steam raising. The removal of the clinker caused a difficulty, as this residue amounted to no less than 32 per cent. of the whole. As the clinker took some time for its removal, cold air rushed into the furnaces and cooled them down considerably. The clinker, however, was ground up and used in the manufacture of cement paving slabs. These slabs, when supported at the edges, supported a pressure, in the middle, of one ton. The feed water was pumped through an economiser in the flue, which raised it to a temperature of 200° Fah. After the water left the economiser it was forced into storage cylinders fixed about 20 feet above the boilers, and connected to them, so that the temperature and pressure were the same. The water descended to the boilers by gravitation. The average amount of refuse received per day was 84 tons, and during the twelve months 26,000 tons were used for the generation of steam. The steam was used by the engines driving the electric generators, and during ordinary times the steam supplied was quite sufficient for the total energy required. But during the evening, when the load was heaviest, coal had to supplement the refuse as a fuel. But the amount of coal was small; only 1,344 tons being consumed. The total Board of Trade units of electricity sold by consumers was 1,031,348, less 131,140 units sent to the destructor. The Manlove Alliott type of furnace is used at Shoreditch, and Babcock-Wilcox water-tube boilers. For smaller towns this appears to be a cheap method of obtaining electric light, and should have the careful consideration of all municipal engineers.

High-Pressure Boilers . . .

ADMIRAL George W. Melville, engineer-in-chief of the United States Navy, recently read a paper on "Causes for the Adoption of Water-Tube Boilers in the United States Navy," before the American Society of Naval Architects and Engineers. Admiral Melville is not enamoured with them any more than he is with electric power for actuating the thousand and one movements on board a man-of-war. But the exigencies of the situation are too many for him, and he confesses that in the case of water-tube boilers he has been forced to adopt them. He is not, like our own engineer-in-chief, a believer in them, and so open to take advantage and make the best of their good points, for it is in a kind of protest against the nature of things that he takes them up at all. He says: "In the first place, I want to state that water-tube boilers are bad in

principle. They carry the pressure inside their weakest parts—the tubes. A failure in a tube is followed by the opening of a fault, sometimes to a dangerous degree. In a fire-tubular boiler, on the contrary, the pressure would continue to close a split tube. . . . Water-tube boilers are, from their very definition, designed from a wrong principle, not only because of the direction of application of pressure upon the tubes, but also on account of the decreased amount of water in the boiler, of the decreased difficulty of observing a leak, and of the decreased value of the heating surface." It appears to us that Admiral Melville, when he says water-tube boilers are bad in principle because they carry pressure in their weakest parts, fails to remember the primary object which is sought to be obtained by the boiler as a machine. The primary object of a steam boiler is not to carry pressure, like a gasometer on a railway truck. The primary object of a steam boiler, as a machine, is to make steam, and everything else of a constructional nature must be held secondary to that. In the case of a warship, this necessity of constructing a steam boiler so that it will make steam quickly is exaggerated. Since the nature of the problem is to get a machine to make steam quickly, it is quite secondary to so construct the parts that they will stand the pressures to which they are subjected. It is not, then, the nature of the problem to make a machine which will be admirable because it supports pressure, but to make it so that it will make steam. But even Admiral Melville is wrong when he says the water-tube boiler is mechanically weak compared with the fire-tube boiler. One of the primary reasons engineers had in departing from the fire-tube boiler, was to obtain a structure which would allow them to work with higher pressure steam. Water-tube boilers have thus been called safety boilers. A tube may burst, but it does not sink the ship, as the bursting of the cylindrical boiler used to do.

Tunnel Ventilation . . .

THE ventilation of railway tunnels is a subject particularly interesting to Londoners, but so far as ordinary underground lines are concerned, it may be doubted whether any absolutely satisfactory system will ever be adopted for the benefit of the travelling public. Of course the substitution of electric traction, which is shortly to be effected on the Metropolitan Railway, will cause a great improvement, but ventilation will still be required if air is to be maintained at the proper degree of purity. Nothing is impossible to engineers in these days, though it may well be that desired reforms are often rendered practically unattainable by reason of their immense cost. Some railway engineers contend that considerable ventilating power results from the movement of trains, but these gentlemen overlook the fact that most of the effect is cancelled by the opposing directions of traffic. Unless the companies be compelled to reconstruct their tunnels so that each line occupies a separate conduit, systematic ventilation must probably remain an unsolved problem. Even in the more recently made electric railways, where separate tunnels are adopted, the atmosphere is not all that could be wished. It may be that the proportion of CO_2 is reasonably small, though on this point reliable evidence is not available. So far as can be judged by the senses, the air does not seem altogether wholesome, and the well-known earthy smell prevailing in tunnels of the kind has been attributed to bacterial or fungoid growth. One medical authority has indeed gone so far as to suggest that subways in which electric traction is employed should be disinfected at regular intervals. Bearing in mind the competition existing on the part of the public for seats, even on the most malodorous underground lines, it is very unlikely that existing railway companies will incur heavy outlay except on the clearest evidence of its necessity in the interests of shareholders, and of its efficiency for the benefit of passengers. In the case of new undertakings we think that satisfactory arrangements for ventilation ought to be insisted on prior to the granting of Parliamentary sanction. In connection with the St. Gothard tunnel, the Saccardo system has given very satisfactory results, and it is to

be hoped that as a nation we shall not continue to occupy a second place with regard to this important subject.

Fire-Proof Wood in Shipbuilding . . .

DURING the course of the Chino-Japanese war, so frequently were fires started on Chinese vessels by Japanese shell, that gunners are said to have spent more time in extinguishing work than in serving their batteries, and it was also the case that almost as many officers and men were disabled by burning spars as by the enemy's guns. Ignited wood, again, was largely responsible for the destruction of many Spanish cruisers both at Manilla and at Santiago. Contrary to the commonly accepted theory, the Spanish vessels did not contain a larger proportion of timber than was usual in warships of corresponding age. Probably in the form of decks, bulkheads, and partitions, they carried even less woodwork than the average cruiser built about the year 1890. Their decks were protected underneath by metallic beams, plates, etc., and the quantity of ironwork in contact with the decks would have the further effect of retarding combustion by reason of its conductive power. Nevertheless, the vessels in question had been only a few minutes under fire, before they were so completely ignited that it became necessary to run them ashore in order to save the lives of the crews. On the other hand, in American ships, where fire-proofed timber had been used, none of the woodwork was ignited, and total destruction in more than one instance was undoubtedly averted in consequence of this precautionary measure. It is therefore to be seen that the Americans made a most valuable application of the lesson taught by the Chinese war, and the indorsement received at Santiago and Manilla led to the decision that fire-proofed wood should be a feature in all future naval construction. At the same time it is highly satisfactory to know that our own Admiralty, after making thorough and prolonged tests, are now introducing non-flammable wood into all vessels built and repaired. This is satisfactory so far as it goes, but we fear the complete supersession of unsuitable material will occupy a longer period than the urgency of the matter demands. Private builders will no doubt follow the lead in course of time to a greater extent than they have done up to the present, and it is to be hoped that all vessels, whether belonging to the Royal Navy or to the mercantile marine, will ultimately be equipped for the effective resistance of fire. One cause always tending to retard the adoption of any new invention is want of faith in its efficacy. We may therefore with advantage mention briefly the salient points in connection with the process of fire-proofing wood, or, more correctly, of rendering it non-flammable. There have been many attempts in the past to solve this problem, the first patent dating from the year 1625. Since that time numerous experiments have been made, but, until recent years, without really successful results. The obstacles in the way of practical application are: (1) the difficulty of securing thorough and uniform impregnation, and (2) the difficulty of finding chemical substances which cause resistance to fire without producing any prejudicial effects. Chemicals of hygroscopic nature are manifestly unsuitable, others are found to produce corrosion in metals, and others again fail in respect of permanency. In the process adopted by the American and British Governments, the timber is treated in an air-tight cylinder into which air, charged with aqueous vapour at a high temperature, is pumped in order to soften the material. Moisture is evaporated by the aid of a vacuum of from 20 to 28 in., and a solution containing phosphate of ammonia and sulphate of ammonia is then pumped into the cylinder under pressure sufficient to ensure complete penetration. A subsequent drying process removes the water and leaves the crystallised salts in the internal spaces. As the result of exhaustive tests, it appears that timber treated in this manner is apt to become combustible after exposure to frequent wettings. It is therefore not entirely suitable for the covering of decks, but in other positions no disqualifying features have been ascertained.

A Great Industrial Year . . .

THE "Accounts relating to Trade and Navigation of the United Kingdom for each month during the year 1899" were issued after our January number had gone to press, but the interest of the Government returns will not materially suffer for a little delay in their consideration.

The closing year of the century will stand out brightly in the pages of history as a year which saw the world's trade and manufactures, its commerce and exchange, attain a magnitude never before approached. After a long period of trade depression, a reaction at last set in. A stagnant market gave signs of renewing vitality. British shipbuilding, an industry which has never shewn any great lassitude, first felt the impulse, quickly communicated to the iron and steel industries. These in their turn reacted on other industries, and an onrush of trade began which in its violence and its volume has defied all foresight and calculation.

It found our manufacturers, or a large proportion of them, totally unprepared. The past year has been a period of desperate, continued, yet unsuccessful, endeavour to cope with the demands made upon them. The orders have been flowing in on all sides. From one end of it to the other, a fever heat of industry has spread over the land. Not in living memory have our ironworks, our shipbuilding yards, our mills, and our engineering shops been so taxed, our operatives called on for such incessant exertion.

The returns before us bear faithful witness to this fact. British trade in the year 1899 attained the colossal value of £814,755,710, a sum whose magnitude the human mind is not capable of appreciating in its material bearings. The increase over the preceding year of 1898 was no less than £50,363,139. The following short tabular statement shows the composition of these figures:—

	Year ending December 31st. 1898.	1899.
British exports of home manufactures and produce ...	233,359,240	264,660,647
British exports of foreign and colonial merchandise ...	60,654,748	65,019,549
Total	£294,013,988	£329,680,196
British imports ...	£470,378,583	£485,075,514
Total British trade for year 1898,		£764,392,571
" " " for year 1899,		£814,755,710
Increase for year 1899		£50,363,139.

NOTE.—The sum of £9,195,192, estimated value of ships built for foreign owners, is included in the figures for 1899. These values were not recorded in previous years.

The last month of last year was not altogether so favourable in its tendencies as earlier months. The exports, it is true, exceeded those of the same month in the previous year by a value of £1,060,081; but this increase is to a considerable degree illusory since the formerly unregistered rate of shipping built for foreign account is included to the amount of £632,270. The returns, indeed, for December show numerous decreases, almost in every class of export excepting in hardware and raw materials. Imports, too, fell away also to the extent of no less than £4,625,890.

Taking these significant alterations in what has been the tendency of our oversea trade, are we entitled to assume that the zenith in the cycle of prosperity has been reached and that we are now on the decline? Assuredly, there is no warrant for such a presumption apart from the figures we have quoted. To all appearance the country is as busy as it has ever been during the past eighteen months, and there is up to the present no symptoms of the hard drive we have had in manufactures slackening. Yet, according to the invariable experience of the past, these trade revivals suffer the fate common to all mundane affairs. They enter upon an existence, grow, attain a climax, decline and dwindle into decay. It is impossible reasonably to expect British trade to be kept up for any lasting period at its present high pressure. It may decline, but perhaps only to advance beyond even its former level. Let us hope that it will; and whilst hoping, remember that the lean years have continued to follow the fat ones ever since the first historical reference to the phenomena embraced in the past, and since we know that they must come, let us be prepared for them.

Notes.

AFTER the Paris Exhibition is over, the American exhibits, or the bulk of them, are to be shipped to Russia and be exhibited over again. There is thrift as well as enterprise on the part of our American friends in thus making their show manufactures do double duty. We are no dogs in the manger, and sincerely wish them success, since Russia is quite large enough to make room for both American and British trade without jostling each other. We rather fancy, however, that although Russia is quite willing to receive foreign exports, she would prefer these in the shape of cash rather than goods. Anyone who desires to invest money in Russia will meet with the most benevolent attention from the Russian Government; but Russia wants to make goods, not buy them.

IT is reported that a German electrical company have succeeded in perfecting the Nernst electrolytic lamp placed prematurely on the British market. It will be remembered that the Nernst lamp required either a spirit lamp or a platinum heater to bring up the electrolyte to a conductive temperature, and this has been found a serious practical drawback. Professor Tessenden is reported to have overcome this difficulty in a very simple manner. The end pieces of the rod to be incandesced are formed of a material that becomes conductive at a lower temperature than the body portion. A part of the circuit, to use the words of the patent, "is formed of a lead adapted to carry the normal current without material change, and to be heated so as to present air abnormally." Should a lamp of this kind be sufficiently perfected, of which there appears every prospect, taking, as it does, only 1½ watts per candle, it will be the most deadly competitor the electric glow lamp has yet had to deal with. Mr. James Swinburne, no mean authority, expressed the utmost confidence in the electrolytic lamp's ultimate success.

THE concession made by the French Government in relation to certificates of origin of English goods imported into France is a welcome one. The consular fee for *visas* to certificates of origin ceases this month. Considering that such fee is five shillings, and that certificate of origin must be taken out for almost every invoice, the saving to British exporting firms will be a substantial one.

AMONG other encouraging symptoms of British industrial progress we would like to put on record two isolated facts pointing to the same conclusion. Some little time ago there appeared—we think in the *Times*—an advertisement from a well-known French engineering house inviting premiumed pupils to their works, where they "would have the opportunity of studying and acquiring the highest type of steam-engine practice." The British Westinghouse Electric and Engineering Company, Limited, it is announced, are preparing to send a number of English electrical students to their associated works in the States, to acquire "about 12 months' experience of good, practical work." It is not so very long ago when the French required British engineers and British "navvies" to make their railways for them: but *tempus mutantur*, and so on.

WE have now gone over the whole of the material sent to us by Mr. Hudson Maxim in answer to our remarks on his article on smokeless powder, published by an American contemporary, and not only have we failed to discover in the publications sent by him anything whatever to shake our opinion, but a careful investigation of documents contained in the Patent Office has thrown a very peculiar light on Mr. Hudson Maxim's claims as an inventor. We shall publish the facts as we have been able to determine them concerning smokeless powder, as well as various other inventions, in our next issue, when we hope to enable our readers to judge for themselves whether our first remarks have been unjust, or whether they have not been altogether too mild regarding proceedings that are somewhat extraordinary.

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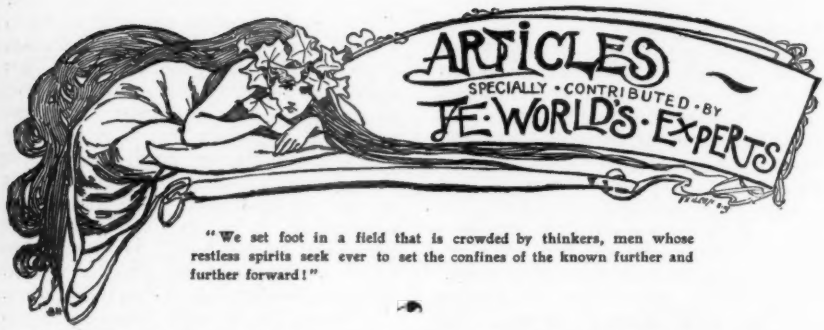
JAMES SWINBURNE, M.I.C.E., M.I.MECH. E., ETC.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

The Electric Tramway and Its Future.

By JAMES SWINBURNE, M.I.C.E., M.I.Mech.E., M.I.E.E., Etc.

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MR. JAMES SWINBURNE was born in Inverness, and was educated at Clifton College. He went to an engineering works as an apprentice when just sixteen, and passed through the shops and drawing office. In 1880, as prospects in mechanical engineering looked poor, he went to the South Shields Gas Works, where he had secured an appointment under Mr. W. J. Warner, the engineer. In 1881 he left the Gas Company as the new work was finished there. He passed first in the City Guilds examination in 1882 in "Gas Manufacture," gaining the silver medal and prize. In January, 1882, Mr. Swinburne made what was probably the first compound wound dynamo for constant potential. Deprez had previously published a combination of series and separate excitation for constant potential, and Varley and Brush had also made series shunt machines designed to preserve their fields, whether short circuited or open circuited; but Edison turns out to have been the first inventor of constant potential winding. Mr. Swinburne afterwards turned his attention to and developed the armature re-action of, direct current dynamos, and later, of alternators and multiphase motors. In 1889 he started a manufacturing business at Teddington on a small scale, during which time he worked out the Hedgehog transformer, and various other instruments, such as the electrostatic voltmeter, and the non-inductive wattmeter. In 1894, Mr. Swinburne gave up manufacturing, and has confined his attention to purely consulting work ever since. He has devoted much time to questions of electro-metallurgy; and has had an experimental laboratory almost constantly going for the last eight years. Mr. Swinburne is a Vice-President of the Institution of Electrical Engineers, a Member of the Institutions of Civil and Mechanical Engineers, and of various other Societies.

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ANYONE with the instincts of an antiquary may be interested in looking at some early patents of a genius of the name of Pinkus, which were taken out about half a century ago. He will there find, if I remember right, an electrical tramway worked by primary batteries. The first approach to a practical electric railway or tramway was the early electrical tramway of Edison and Siemens and Halske. Which was the first I do not recollect; and the matter is not of the least importance. The real history of electrical tramways began about thirteen years ago. At first, various systems of culvert were tried, but the electrical tramways only really began to make rapid progress when the trolley system of traction came into use. The term "traction," meaning drawing, is generally

out of place in connection with electrical tramways.

It may be as well not to trouble about the history of electrical tramways, as that is rather out of place outside an encyclopædia, and it is better to discuss the merits of the different systems for different towns and country districts, and give some attention to the very important question of the legal position of the industry, and the relations of local authorities to the development of electric railways, and the still more important question of their probable future.

The trolley system has the obvious advantage of cheapness, combined with efficiency. It has the disadvantage of earth return, with consequent electrolytic troubles, and the drawback of unsightliness. Compared with accumulator, steam, gas, or oil systems, it has also the drawback of demanding special permanent way, and a system of electrical distribution. As to the drawback of the appearance of overhead wires, this is, to a very small extent, genuine. As soon as enterprising companies tried to introduce electricity, the local authorities objected. The objection seems to be, largely, the deeply rooted aversion to anything new which is conspicuous in savages, and still occasionally appears even in town councillors and local authorities. The unsightliness of the trolley wire and the poles and gear has been made a rod to beat the electrical tramway. There is some truth in the objection, of course, but in most cases the advantage of electrical power so completely overbalances the æsthetic objection, that this opposition is simply absurd. Unfortunately, the average English town, especially the busy manufacturing town, where the tramway is chiefly required, is not so lovely that an overhead wire is a greater eyesore than the rest of the scenery. While the overhead system was bitterly opposed in this country, and people talked of speculators, actuated solely by greed for gain, obscuring the blue vault of heaven by putting up trolley wires in streets like the City Road in London, Continental towns like Zurich—which are not only beautiful, but depend largely for their prosperity on their reputation for beauty—were putting down electrical tramways on the overhead system, The unsightliness of the overhead wiring is a good deal reduced by the Dickinson arrangement of trolley wire and rod. This disposition simplifies the suspension over curves, and a good deal even on straight roads. It is curious that it is seriously urged against the overhead system, over and over again, that it is obstructive. It is not the overhead wires that cause obstruction, it is the confined route prescribed for tram lines. This is common to all tramway systems, whether worked by horse, mechanical, or electrical power.

The question of earth returns is much more serious. It is very easy to say, in an airy way, that if you have good rail-bonding practically all the current will come back by the rails and return conductors. The question is really exceedingly difficult and obscure. The common idea, that electrolysis cannot occur unless you have enough pressure to decompose water, is unfortunately erroneous. The least difference of pressure is capable of producing electrolysis and corrosion. No doubt a well bonded roadbed, with separate metallic returns to assist, and the rails laid in concrete, will minimise the trouble; but it must be remembered that the systems of tramway distribution are at present small, but rapidly growing, and the corrosion of water and gas pipes is a matter that goes on day after day, and year after year, and the difficulty increases enormously with the area of distribution. The only way, short of insulated return, to minimise the trouble seems to be to use return feeders. The rails are then kept at practically the same pressure as the earth. This demands that in a large system the rails carry very little of the whole current back to the station; they only carry it to the nearest return feeder. The return feeders are insulated, and go back to the station. Any convenient loss in the return feeders can be allowed; for instance, if the system is designed for a maximum loss of 20 volts in the returns, and the trolley is, at any rate near the station, to be at 500 volts, the dynamos give 520 volts, one terminal being 500 volts above the earth, and the other 20 volts below; and each feeder has thus a

drop of 20 volts. At lighter loads less loss in the feeders will occur; but all that is necessary to keep the rails at zero pressure is to ensure that there is the same loss in all the feeders. This can be secured by cutting feeders in or out as necessary, or by having adjustable resistances in the feeder circuits. Auxiliary dynamos in the feeder circuits can also be used, each circuit having a machine which adds just the pressure lost in the feeder. By running such a machine at constant speed, and winding the field in series, it becomes self-regulating. This system is not so simple as the return feeder with resistance regulation.

Another scheme is worth suggesting, but I have not worked out the cost. It is to generate and distribute alternating current energy. Each car carries an alternating motor, which runs at uniform speed whether the car is running or stopped. The motor drives a direct-current generator which drives the ordinary motor. This gets over the difficulties of long-distance distribution; and as alternating circuits can be easily localised, the earth is no longer, to use the language of an eminent counsel, "converted into an electrical cesspool." It also gives the advantages of the Ward Leonard, or Vaudepoele system, namely, getting just the pressure and current you want on the motor by varying the field of the generator. The dynamotor would be small and run at a high speed, thus securing high efficiency and low cost; but even then it is a question how far such a system would pay.

The chance of the electrolysis due to the earth return, and not the existence of overhead wires and poles, is the real evil of the trolley and any other earth-return system.

The corrosion of pipes may be minimised by special protection of the "danger area." The rails may be to a great extent insulated by concrete. Cast iron is eaten less than wrought. Lately it has been proposed to use stoneware pipes for gas and water, such as are now used for drains and sewers, but this would mean relaying the pipe systems. Scape-goats of plates of spelter, electrically connected to pipes in dangerous places, would doubtless save the pipes a good deal. Even old rails might do for this purpose.

The culvert or underground system is talked about a great deal, but not often seen. It always figures largely in parliamentary inquiries. When a company wants to put down, or rather put up, a trolley system, it is opposed; and it is told that it ought to put down an underground system, the opposers knowing very well that if the company cannot get leave to put down anything but an underground system, it will not put down anything at all. The drawbacks of the trolley system as generally put forward are unsightliness, danger, obstruction of traffic, and obstruction of fire-escapes; and the culvert system is supposed to obviate this. As far as unsightliness goes, that is much more a means of raising prejudice than a real drawback to the overhead system; but as far as it goes, the underground system gets over this difficulty. This is also true as regards danger to life and obstruction of fire-escapes, as far as these are real, substantial objections. But the underground system has drawbacks of its own which much more than counterbalance these. In the first place, it is more expensive and more difficult to keep in order, and tends to require more taking up of streets, which is itself a very serious drawback. As to obstructing traffic, the culvert system is worse, for the overhead trolley has no effect on traffic at all, while the underground system demands—in addition to tram lines, common to both, which are themselves a nuisance to all other traffic—a slot which is apt to catch the wheels of other vehicles. The capital is considerably greater; but the importance of that depends on the car service. In a street, for instance, where the cars follow one another very closely—for example, in New York, where they practically form a continuous procession—the interest on the capital is a very small matter. Buda Pesth is always quoted as an example of successful culvert working; but in Buda Pesth the slot is very wide, nearly $1\frac{1}{4}$ in. in many places, and there are other circumstances which make a difference. Buda Pesth is not in the least like any

English town. It is only in the main parts of the city that the culvert system is employed. Instead of having culverts with open slots, various surface contact systems have been more or less worked out. These systems get over the drawback of having an open slot along the street, with its attendant troubles of interference with traffic, and mud and snow getting into the culvert and giving rise to leaks. Surface studs are themselves by no means free from objection, as they must more or less give trouble to traffic, especially if the road is worn away so as to leave the studs sticking up unduly. In addition to this, there is always the possibility of some of the studs being left connected to the supply circuit, or electrically alive, after the car has passed on; and this would most likely mean a shock to a horse or an aunt, who are both highly sensitive to such things, and thus might give rise to serious results.

The conduit and trolley systems cannot be compared and judged in any offhand way; which is best, depends entirely on the local conditions.

The accumulator system is likely to be very much more important in the future than it is at present. The electric accumulator has for a long time been very nearly good enough for locomotion, but not quite good enough. The secondary battery has, like the incandescent lamp, undergone very little improvement since its practical introduction nearly twenty years ago. It has been improved in details, but that is all; we are still tied down to lead as a material for the plates, and lead and its compounds for the coatings. Now, the vital question in accumulators for moving is weight. It is clear that a battery may be so heavy that it cannot be made to carry itself any reasonable distance. You cannot get over the difficulty by adding more cells, because that means adding more weight. For the purposes of storage for central stations the cardinal points of a cell are efficiency, cost and durability; and weight does not come in, except so far as it influences the cost. Electrical engineers and a great many other people have been working at the improvement of cells for station work for the last twenty years, and the engineers have succeeded to a great extent; but the same amount of attention has by no means been given to the tramway accumulator, where weight is of such vital importance. Recently the sudden development of electrical tramway has turned attention to portable cells; a great deal of work has been done on light cells. For tramways it is necessary that the cell should be light. To make it light the plates must be flimsy, for, at any rate, lightness generally tends towards flimsiness. Increased lightness means high rates of charge, or at any rate discharge, which is more important. Large capacity per pound of cell is antagonistic to durability, and so is high rate of discharge, indirectly. We thus want to get a cell which has a high rate of discharge, which tends towards short life; long life, which means the opposite quality; and we want lightness, which is opposed to durability and large capacity. In addition to this, it must be borne in mind that the durability is very largely affected by vibration. Vibration is the greatest enemy of the cell. Lead is about the worst metal as far as resistance to vibration goes, as it has no springiness. The coatings of lead and lead compounds are also very easily affected by vibration; the coatings are not only inelastic, but they are continually expanding and contracting on charge and discharge; and even in an ordinary cell, such as used in stations, one of the great difficulties is to obtain perfect adhesion between the coatings and the support. It is not only that the coating should stay in place, it must remain in electrical contact with the lead plates. If the coatings get appreciably loosened so as to be out of electrical contact, they become merely idle weight; but if the material gets shaken off the plates it settles down at the bottom of the cell, and gives trouble by short-circuiting it.

It is for these reasons that a report of a consulting engineer, based on laboratory tests of an accumulator, is generally useless. It is very easy to make a cell which will show enormous capacity and high

discharge in the laboratory; for these qualities are readily obtained at the cost of durability. A cell which may give high discharge and good capacity may come to pieces after a few months' test, even in a laboratory; and it is much more likely to come to pieces in actual use, with a varying discharge and perpetual jolting. No reports on cells after mere laboratory tests are therefore useful. A report, to be valuable, must give the results of prolonged practical work, involving the questions of durability and ability to stand jolting. This is important, because a great deal of capital has been spent in trying to develop accumulator systems backed by favourable reports based on short laboratory tests.

As to the present position of the accumulator for tramway work, it is now very nearly good enough for practical use, and it is no doubt capable of still greater improvement; so that the accumulator may soon be a very important factor, especially in flat districts. That is why it is so fully discussed here. The accumulator has enormous advantages over any other electric system. It has no trolleys; it demands no underground system; it has no troubles due to electrolysis; and its only drawback is that the cars are heavy, and therefore demand a somewhat better road-bed.

There is one special case in which accumulators are already filling a very important position. Where the tramway people find it impossible to persuade local authorities that the trolley system is beautiful, they have sometimes been allowed to run it in the outskirts of the town. The cars are then provided with accumulator cells and trolley attachments. The cars run with their accumulators in the business and presumably beautiful parts of the town, where people have nothing to do but to admire the panorama; and in the ugly residential outskirts, where it does not matter, they run on the trolley system, the accumulators being charged at the same time. In this case the accumulators have only to drive the cars a comparatively short distance; so they are fairly light, and there is plenty of margin. This system was first introduced in Hanover, or at least Hanover was the first town in which it attracted general notice. The system is now applied in Berlin and elsewhere, and seems to have a great future before it. It will not only get over the difficulty, but it supplies a sort of trying ground for moving accumulators; and there will be a general tendency to increase the proportion of the distances worked by accumulators and decrease the trolley part until, perhaps, eventually the accumulators do the whole of the work. This, of course, means that the cars will either have to be stopped for charging, or the accumulators may be changed which only involves a short stop.

The accumulator system, without any dependence on trolleys, has been at work for some time in this country and elsewhere, but has not been able to compete with the trolley system in the favour of electrical engineers. But as the accumulator is improving, this form of locomotion seems more promising. As an instance, the system at Ghent may be mentioned.

We have now discussed the various electric systems, though very shortly; and it may be worth while to mention some of the others, and then to look at the whole question of traction a little more broadly.

The only rival systems are gas traction, steam traction, and the cable. Steam traction has been in use in several towns for some time, but as its electric rivals have proved so very successful against competitors already in the field, it may be safe to assume that the old form of steam traction has no longer any future.

As regards gas tramways, the case is different. Gas is in use, and is making some way, and the figures, as given by the Gas Traction Co., are quite satisfactory. As to oil and gas, and other probable developments, this is a very large question, which is perhaps more important than generally realised by electrical engineers.

There is a good opening for a competent prophet in connection with the future of electrical tramways and road traffic. What is wanted is a definite prophet, not a vague gentleman whose reports fit anything that happens subsequently. As there is no consulting prophet ready for

a retainer, the only thing is to try and prophesy yourself; and the best way is to look at the progress already made, and to see, if possible, in what direction it is tending. The most important factors are, I think, three:—In the first place, we have a sudden awakening and tremendously rapid development of trolley work. This, taken alone, would lead us to expect that the horse is doomed, as far as road railways are concerned, just as the stage coach horse was doomed as soon as stage coaches developed into railway carriages. Electrical trams are always opposed by the local authorities unless they want to take them up themselves, and the inhabitants of a district generally object, not only to the introduction of an electric tramway, but even to the change from horses to motors on an existing tram-line. As soon as the electrical tram comes into being everyone is delighted, and the most bitter opponents become the strongest supporters and take credit for having introduced the improvement. It looks, therefore, as if electrical tramways on the trolley system had the ball at their feet, and that the ball is already rolling rapidly and with considerable acceleration.

The next factor we have to consider is the rapid development of municipalisation. If the electrical tramway is put down by a company the local authority has power to buy it at a low price after a certain term of years. This means that if the local authority does not like to take the risk it is in the position of either depriving its ratepayers of the convenience altogether, or it waits till a company comes forward which has sufficient confidence to take the risk on the principle of "Heads I win for a few years only, and all the rest of the time the local authority gets the benefit, and tails I lose, and the local authorities bear none of the brunt of the battle." This state of the law has been most disastrous to the interests of the public in this country, and the tramway system has never properly developed. It has hampered enterprise in the initial stages and prevented the starting of tramways, and during running, especially towards the end of the term of years, the tramway management of course becomes slack and invertebrate, as there is no motive for improvement or even of continued efficiency. But municipalisation is developing still more rapidly now; and as it is clear that, in spite of legal difficulties, electrical equipment of tramways pays companies, local authorities are rapidly developing electrical tramways. But here we come at once on a great difficulty. Apart from the question whether a local authority is likely to manage a tramway system as well as a private company, the trouble arises, that as soon as tramways develop beyond local towns into suburban systems, each tramway system comes under several local authorities. This difficulty of a system running through the districts of several local authorities comes in as regards companies as well as local authorities, for the ultimate purchase must be considered, and each authority wants to have the system so arranged that it can buy up something complete and satisfactory in itself. The question is further complicated by electric-light stations, which, of course, ought to work in combination with the tramways. One large generating station cannot be dearer than two smaller ones. This question of purchase and of local control is very much more important than is generally realised by electrical engineers. The present Electric Lighting Act, for example, is entirely inapplicable to modern conditions. It puts every difficulty in the way of economical systems of general distribution from large stations, and stifles industry. It might be bad taste to say much about municipalisation in a lecture given under the auspices of the Corporation of Dublin.* Besides, everybody is talking about municipalisation just now, and it is becoming a party question, which means that both sides shout without either listening to what the other has to say; so that a little silence may be refreshing. But whether municipalisation or private enterprise is the best thing, the present state of the law as regards both kinds of electrical distribu-

* This paper is nominally a report of a lecture given at Dublin, under the auspices of the Technical Schools of the Corporation of Dublin.

tion is anachronous, and does not at all fit present-day electric developments.

Reverting to prophecy, most people's idea of an automotor is a hullabarattle and a smell, with a casualty notice next day; but it will soon deserve a better reputation. The motor car has been kept down by legislation, and has only just begun to develop. Its prospects have suffered heavily at the hands of the company promotor, but now it is really a question of engineering detail to make practical automotors. Those of to-day are hardly specimens of good mechanical engineering; the trail of the bicycle-maker is over them all. But they will gradually improve, as experience and engineering skill are brought into play.

We are so accustomed to things as they are that we are apt to think they necessarily must be so, and to overlook the reasons why they are so. Why are there street railways at all? Roads are so bad that in order to get reasonably easy haulage a little special iron road is put down. Mr. Beaumont has put the whole matter in a nutshell; tramways are a protest against the badness of roads. In order to get at least some good strip of road, however narrow, tram-lines are put down, which benefit the tramway companies and their passengers, who are a large section of the public. But the lines are a perfect nuisance to every other user of the road.

Comparatively little attention is being devoted to the development of oil or steam tramway cars. Steam is, of course, in extensive use, but the steam tramcar as brought out some twenty years ago is giving way to the trolley system. The more modern steam car, with water-tube boiler and, perhaps, petroleum fuel, may reverse this again. At any rate, the recent developments in steam vans make it probable that steam will have another innings on tram lines, in spite of the fact that stationary generators with electric distribution can oust steam on many railways. On a short railway there is every facility for electrical transmission, and the problem is quite different. The oil motor is a much more serious matter. It is much younger than the steam engine, and is already very well grown, and may take its place on the tramcar any time soon. Of course this means saving of capital in generation and distribution, and overcomes the difficulties and drawbacks inherent in electrical distribution. If steam or petroleum motors come in for tramways, much of the capital outlay now being invested will be wasted. But this is not the most serious aspect of the question. The chief drawback to street locomotion is the horse. He is nearly as foolish as the hen, and he is dirty and insanitary on a larger scale. He has been with us over five thousand years, and has not learned even manners or decency. It is the fashion to extol the horse as a noble animal, and all that sort of thing, but that is largely would-be sporting cant, primarily based on the expense of riding.

The horse, though not a snob himself, is intimately connected with snobbery in some occult way. Look at a horse with a man on; the horse looks modest enough, but there is an indescribable inflation in the man, unless he is falling off. The horse is expensive to keep, but that is only one point; he is mixed up with the idea of the country gentleman and landed proprietor of county family. He is involved in the "England's greatness due to the hunting field, Westward Ho, Waterloo won on playing fields of Eton,* 'Broke the ice on my tub this morning,' classical education makes a gentleman, thoroughly manly and English, noble sport of horse race gambling" sort of cant. This is really a very strong factor, which will prevent the autocar being taken up by people who pose as possessing the true English love of the horse. The real lover of the horse is rare, but the snobbish wish to be considered a lover of horses or a sportsman is very common. The country magistrate has it, of course, and will use his power to inflict every injustice on automobilists, as he has already on cyclists. Country members of Parliament may also help to secure legislation in favour of the

* This assumes that Waterloo was won by officers only. The men do not count. The present war shows the men are heroically plucky as well as the officers, but war critics like myself who know nothing of the subject say that what we want is brain and common sense.

horse, as they consider sport the foundation of England's greatness.

We have been so accustomed to the dirt of the horse all our lives that it seems natural, and we hardly realise what it means. A large town is really a colossal midden with houses dotted about in it. It is a shallow midden, no doubt, but middeniness depends on surface rather than cubic contents. Total middenance, as Heaviside would call it, is a surface not a volume integral. Not content with the state of our streets, the well-to-do have special middens as close to their houses as possible, which they call mews. The mess is not confined to the streets either—it is everywhere. It dries and forms dust, and is blown into our houses. The delicate lady sweeps up a little cloud of it with her skirt; the wind wafts it, with millions of germs—many of them pathogenic—into our beds, our clothes, our books, and into all our food and drink, and into the milk of our children and curates; and we breathe it in our drawing-rooms. In fact, the young poet kisses it on his lady's lips, and would discontinue such proceedings if he knew anything of modern science. This is a horrible subject; but however revolting it is, we can only make it better by realising the truth of these matters. Pod-snappery is no use.

The first disadvantage of the ordinary vehicle is that it spoils the road. It takes up too much room for the people carried. A hansom is perhaps the worst vehicle of all as regards room, and a victoria next. Taking speed or time the space is occupied also into account, the bicycle is the best means of locomotion in use. One necessity for good locomotion is uniform speed. The slow lorry and the stopping van are the chief obstructions in town streets. All vehicles should move at a uniform rate of, say, ten miles an hour. Cart horses should learn to be more fluent with their legs—or disappear. Pedestrians on the pavement should all walk at four miles an hour, and all wheeled things, including perambulators, should go in the roadway at ten miles an hour.* The automotor will probably give us the possibility of running everything at a uniform high speed. More than this, the abolition or even the serious reduction of horses, coupled with smooth non-hammering wheels, means good smooth roads, easily kept in repair. If the streets and roads are smooth and hard; in fact, if we have decent roads and successful automobiles, the need for tramways, electrically or otherwise worked, is gone. If an automotor omnibus can carry as many passengers as a tramcar, and if it can run on a smooth road as easily as on rails, the whole reason for existence of the tramway, electrical, horse, or mechanical, has vanished. The tramway lines become merely an obstruction in themselves, and the cars a nuisance in their inflexibility of route.

It may be truly said that such changes as these are in the far future, at the most. That is so. The petroleum and steam cars will need a great deal of improvement first. Then, when they begin to come into use they have to run the gauntlet, like every other novelty. They will have to undergo the same ordeal as the cycle. The cycle has been in large general use for about eight years now, but it is hated with religious hatred by all old ladies, especially of the aunt type of mind, and nearly all magistrates. The motor car must undergo years of police persecution, and perhaps hostile legislation will help to retard it. Like the cycle, it will suffer by beginning at the wrong end of society. There is another drawback which is not fully enough realised. Though the horse is by no means intellectual, it has a large share of the intelligence that controls vehicular traffic; and it will be found that it is much more difficult to drive motor cars than traps. Moreover, the horse has at least the virtue of comparative sobriety, and it is unusual outside our large towns for a horse and his driver

* What is a perambulator for, anyhow? It is supposed to exercise the baby. It would get exercise if put on the floor at home and allowed to kick. From an engineering point of view, a baby in a perambulator, well lagged all over with woollen nonconductors except, perhaps, one leg, is exposed to differences of temperature which must give rise to injurious internal stresses. It may be to get air, but then it would get air just as well in a properly ventilated nursery, or if it were hung out at the window or put on the roof, and it would then be further away from the horse mess of our roads. It cannot be for change of scene, because babies do not admire scenery, and generally sleep when out. Perambulators are used because no one realises how idiotic they are. Their real effect is to exercise the nurse, and that would be much better done at ten miles an hour in the roadway, the baby being left at home—preferably on the roof. But what would our aunts say to that?

to be intoxicated at the same time. What we are to expect when motor cars get into the hands of inebriated drivers is beyond the limits of present prophecy.

The automotor is not likely to influence the electric tram for a few years at the very least, but it must be remembered that the elaborate systems now contemplated or being erected in large towns must take many years to repay the capital outlay. Who can say whether in ten years the motor 'bus, running quickly, smoothly, silently and cheaply on smooth roads which take little repair, will not completely oust the electrical tramway with its capital cost and its inflexible system? The auto-'bus does not need to begin on a large scale; it can commence competition any time by private enterprise, and unless the local authorities keep the roads bad, out of pure obstructiveness—which is not likely—they have no means of checking competition. We are starting electric trams here ten years after everybody else. One result is that we start with the best experience of other countries; another is, that we start with a system which is ten years older, and, though more robust on that ground, is nevertheless ten years nearer its death. Compared with independent autocars—assuming good ones to exist—the electrical tramway, on any of the present systems which necessitate tramlines and permanent distribution of power, must, when looked at broadly, appear a very makeshift sort of arrangement. But, most important of all, automotors which are not worked under provisional orders and purchase clauses, or stifled by legislation in favour of municipal monopoly, will be at a tremendous advantage when the competition really commences.

James Swinburne

The Bacterial Treatment of Sewage.

By SAMUEL RIDEAL, D.Sc. Lond., F.I.C.

(Continued from page 27.)

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Among the advantages of the bacterial processes, involving a large anaerobic preliminary chamber, is the ease with which the works can be adapted for dealing with storm water. As is well known, the first discharge after rain brings down a considerable quantity of very foul matter, which has accumulated in the sewers, and therefore it is most important that the first quantities of storm sewage should be thoroughly and effectively treated. The Local Government Board have for many years past criticised very carefully the schemes submitted to them with a view to seeing that adequate provision for dealing with storm water has been ensured, and at the present time no scheme meets with their approval which does not involve the construction of works capable of dealing with three times the dry weather flow, and, secondly, of dealing with an excess of storm water equal to this quantity, and therefore up to six times the dry weather flow, by filtration or land irrigation. It will be seen, therefore, that at present the idea involved in these rules is that the solids must be removed from the sewage in cases of storm up to three times the dry weather flow, but that when this quantity is exceeded, either the solids have already been scoured out of the sewer and thereby dealt with, or the quantity is so small that they can pass with the water on to the filters or land without nuisance. Now, in any system involving an anaerobic preliminary treatment, provision is made for the subsidence of solids, as well as for their liquefaction, as a tank constructed to hold the dry weather flow of a sewage for 24 hours would admit of six times the dry weather flow passing through such tank by reducing the time of stay from 24 hours to 4 hours. The rate of flow under such conditions would still be so slow as to ensure the retention in the tank of the whole of the suspended solids, and these would therefore accumulate during stormy weather to be digested by the tank at leisure during the dry weather periods. A curious anomaly arises out of these considerations. If the time of sojourn in the tank is reduced owing to the rate of flow through the tank being increased, the liquid products of hydrolysis usually contributed to the effluent from the stay in the tank will not exist in the effluent water to the same extent. In other words, the effluent from such a tank during a storm will be purer than from the tank in dry weather proportionately to the rate of flow, even after due allowance has been made for dilution, provided only the rate be not so high as to bring untreated suspended matter to the outlet. Mr. Martin has well illustrated this point in a paper at the Southampton Congress, in which he has shown that the Barrhead Works, already described, will fulfil these conditions. As a matter of fact, the velocity of flow in the tanks at Barrhead with three times the volume of the dry weather flow passing through them would only amount to $1\frac{7}{8}$ in. per minute. With six times the dry weather flow, therefore, the velocity would not exceed $3\frac{3}{4}$ in. per minute, which is obviously so slow a rate as to be powerless to disturb solid matter in the tank.

It will be well at this point to tabulate the progressive stages through which the natural purification runs. (*Vide Table, p.* 136).

The initial change usually takes place even before the liquid enters the main sewers. An important point, which I have always emphasized, is that the subsequent steps, as they are accomplished by different classes of organisms and under different conditions, should be kept as far as possible regular, separate, and constant, and that

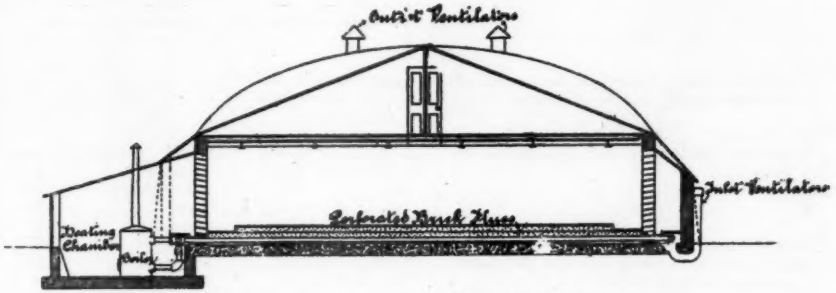


FIG. 11.—SECTION OF DUCAT'S BACTERIAL SELF-ACTING FILTER.

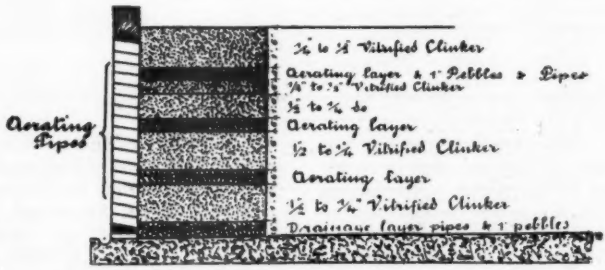

Aerating Pipes
¾" to ½" Vitrified Clinker
Aerating layer & 1" Pebbles & Pipes
⅜" to ½" Vitrified Clinker
½ to ¾ do
Aerating layer
½ to ¾ Vitrified Clinker
Aerating layer
½ to ¾" Vitrified Clinker
Drainage layer pipes & 1" pebbles

FIG. 11A.—FILTERING MATERIAL.

the extent to which any special system fulfils these requirements enables us to judge of its soundness and capacity. In reality, none of the existing processes are quite free from the fault of a mixing, oscillation, or irregularity of the separate stages, the defect arising principally from the effort to economise space by compressing the *three* stages into *two* areas.

In the recent London County Council Report, Dr. Clowes and Dr. Houston show that they have been continuing the experiments on the intermittent treatment of London sewage by coke beds, on the lines of Mr. Dibdin, with special reference to the size and depth of coke required. Permanence, volume-efficiency per unit of surface, effect of secondary treatment, and bacteriological character of the effluent have also been carefully studied.

As I had predicted in my Cantor lectures, the increase of depth beyond 5 ft. has not been attended by higher efficiency. The report states that "coke beds similar in character, but differing in depth, have been found to give practically identical purifying effects . . . . . with a 4-foot and with a 6-foot bed. A bed 13 ft. in depth . . . has given a purification approximately equal to that effected by the 4-ft. bed." The depth is always of great importance both as to fall, volume, and cost. In the intermittent system, the bed is really used at intervals as a storage tank, so that, in this sense, greater depth means higher capacity.

An important point in the report is that the capacity of the 4-ft. bed had, during 10 months, been reduced from 50 to 33 per cent., "mainly due to fragments of straw and chaff, apparently derived from horse-dung, and to woody fibre from the wear of wood pavements. . . . The original capacity is not restored in any degree by prolonged aëration, which proves that the deposit on the coke surface was not organic matter of animal origin." This result confirms the view which I have frequently urged, namely, that these non-animal substances cannot be successfully destroyed without anaerobic change, by which they are dissolved with produc-

	Substances dealt with.	Characteristic products.
INITIAL.		
Transient aerobic changes by the oxygen of the water-supply, rapidly passing to ...	Urea, ammonia, and easily decomposable matters.	
FIRST STAGE.		
Anaerobic liquefaction and preparation by hydrolysis.	Albuminous matters. Cellulose and fibre. Fats.	Soluble nitrogenous compounds. Phenol derivatives. Gases. Ammonia.
SECOND STAGE.		
Semi-anaerobic breaking down of the intermediate dissolved bodies.	Amido-compounds. Fatty acids. Dissolved residues. Phenolic bodies.	Ammonia. Nitrites. Gases.
THIRD STAGE.		
Complete aëration: nitrification.	Ammonia and carbonaceous residues.	CO_2 H_2O and nitrate.

TABLE SHOWING THE PROGRESSIVE STAGES THROUGH WHICH THE NATURAL PURIFICATION RUNS.

tion of gas. They are the great difficulty in all processes where the first or hydrolytic change is not properly specialised. The degree to which the animal matters are dealt with cannot be traced from the report, as only the "oxygen absorbed" figures are given, and it is obvious that if the non-nitrogenous suspended matter is arrested by the filter bed, the improvement in the effluent as measured by the "oxygen consumed" figure must in part be attributed to this cause, at the expense of clogging, or diminution of capacity.

I have already remarked that the first stage requires *no* oxygen, and is actually hindered by it, the second requires some, while the third demands a very large and rapid supply. In place of providing three separate areas in which these conditions are carefully and continuously observed, as we should in the culture of plants which required different amounts of water, heat, or manures, it is attempted to alternate them in *two* receptacles by causing the air in each to be cut off and supplied intermittently, and the sewage to be either stagnant, or run in and out with a rush, with the result that the bacteria are periodically disturbed, and neither class of organisms can work under their normal vital conditions.*

My own analyses and those of others have proved that under the intermittent system, first adopted from the laboratory experiments of Sir E. Frankland in 1870, the effluents, although the *average* results show a great improvement, yet manifest such fluctuations in character, tending to be periodic, as show that the quiet and regular working of the bacteria suffers avoidable interruption and interference. A small significant fact is that the discharge from the fine beds at Sutton and Exeter, and I believe in other places, is always at the first rush turbid and of inferior quality, as a consequence of disturbance.

The want of provision of a separate area for the first stage is often concealed by the fact that where the sewers are old or of great capacity or length, or when the sewage has been stored for sedimentation, the first, or even a part of the second stage may have actually been passed through before the liquid reaches the works, so that the liquid may be quite amenable for the third stage of strong aëration, such as is supplied by Lowcock's, Waring's, and Ducat's systems.

Lowcock, at Malvern and Wolverhampton, about 1892, forced air under a pressure of 4½ inches of water through a gravel or coke-breeze bed. Waring, in 1894, at Newport, New York, after separating the sludge, treated it in

* In the Manchester inquiry this year it was stated that if the "double contact" did not suffice, they would employ a "third contact."

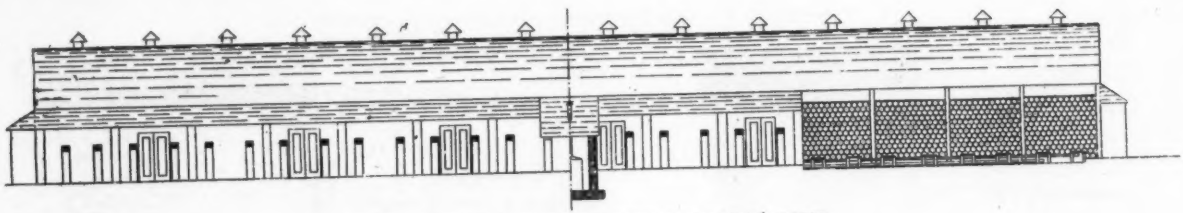


FIG. 12.—LONGITUDINAL SECTION AND ELEVATION OF DUCAT'S FILTER.

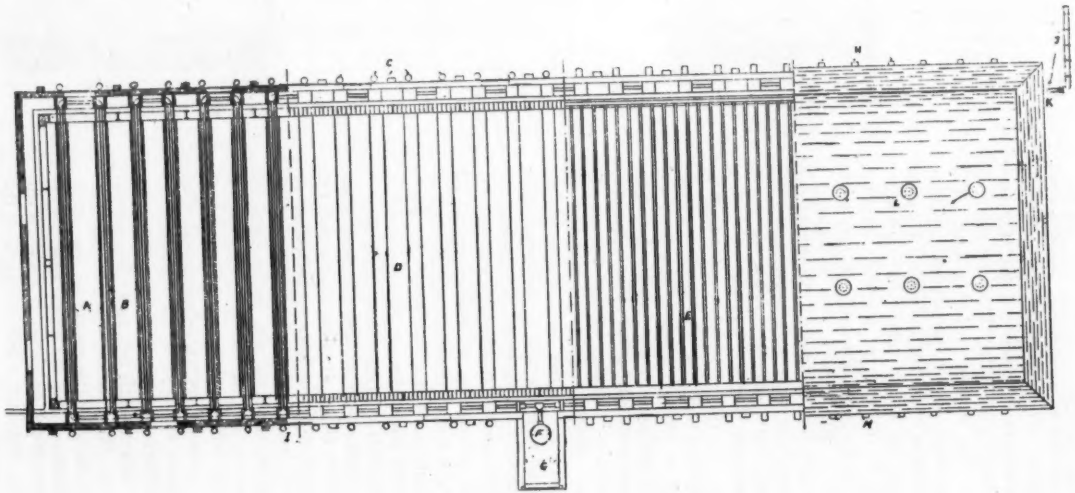


FIG. 13.—SECTIONAL PLAN OF DUCAT'S FILTER.

(*a*) Perforated Brick Flue; (*b*) Heating Pipes; (*c*) Inlet Ventilators; (*d*) Floor of Filter; (*e*) Automatic Tipping Channels; (*f*) Boiler in Heating Chamber (*g*); (*h*) Inlet Ventilators; (*i*) Outlet Ventilators; (*j*, *k*) Regulating Valve and Distributing Channel, with Weir Valves.

"aerators" with forced currents of air. Each of these methods increases the expense of treatment in proportion to the power applied.

Col. Ducat constructs an aërating filter with walls of 3-in. drain-pipes set nearly horizontally in Portland cement, the inner ends being 3 in. lower than the outer, to prevent the sewage running out. The free exposure to air introduces considerable cooling, rendering necessary a special provision by larger pipes for hot-water heating in winter to prevent freezing. Here, again, the reliance on air alone introduces an element of expense. I understand that in recent installations of this filter, provision is being made for a breaking down of the organic nitrogen into ammonia before aëration, though it appears, by the analyses published in 1898, that in the filter at Hendon a large quantity of ammonia was carried off by the air without being nitrified. The organisms cultivated in this apparatus must obviously belong to the two classes of which Bacillus nitrosomonas and B. nitrobacter are types. The satisfactory continuous working will be ensured, after these growths have been developed, by the ample provision of oxygen. In this filter, as in others, a deficiency of air supply will reveal itself by a decrease in the activity in the colonies of B. nitrobacter, and therefore in the presence of larger quantities of nitrites.

The illustrations of Ducat's and Lowcock's filters (Figs. 11, 11A, 12, 13 and 14) are from Mr. Mansergh's recent report to the city of Baltimore.

It is impossible for me, in the scope of the present article, to say very much about the construction and material of filters. I am, however, convinced that good results are obtained from materials of very different character, and that success is determined far more by careful attention to the construction and method of using than by the nature of the filtering medium. The material, after all, is only a framework or skeleton dividing the space into sections or zones, in which the bacteria can carry on their work undisturbed. This conclusion is amply borne out by the many published experiments

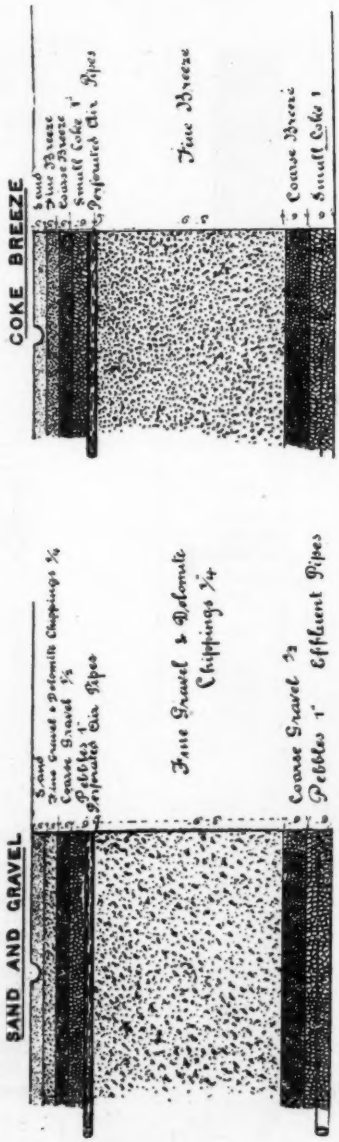


FIG. 14.—SECTION OF LOWCOCK'S AERATED BACTERIAL FILTER AT WOLVERHAMPTON.

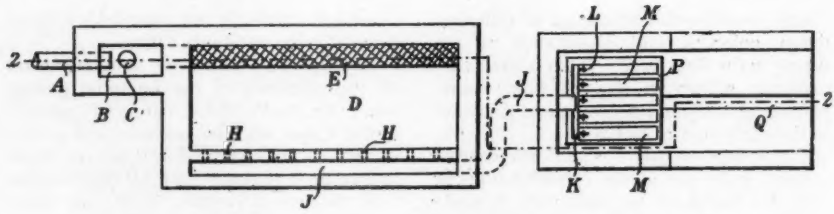


FIG. 15.—PLAN OF SCOTT-MONCRIEFF CULTIVATION BED AND BACTERIAL FILTERS.

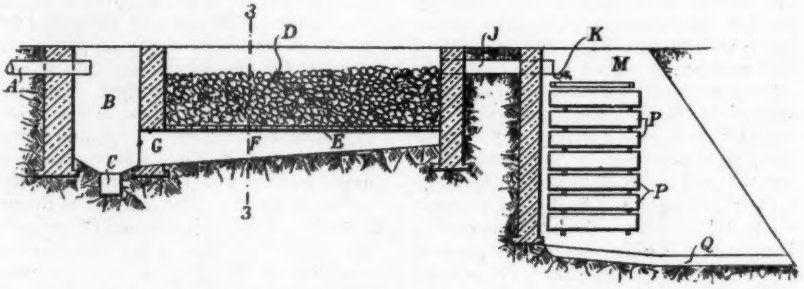


FIG. 16.—SECTION OF SCOTT-MONCRIEFF CULTIVATION BED AND BACTERIAL FILTERS

on the influence of the nature of the filling substance as distinguished from the size of its particles and their arrangement and aggregation.

Mr. Garfield and Dr. Bostock Hill still claim exceptional virtues for *coal*, but it was only at Southampton that these investigators admitted the desirability of subjecting the sewage to a preliminary "resolving tank," equivalent in all essentials to a septic tank or Scott-Moncrieff cultivation bed, to prepare it for their coal filter. In their paper at the Sanitary Congress recently, they stated that the sewage (at Wolverhampton) passed, on its way to the outfall, through a syphon which held about 24 hours' flow, "so that, in fact, many years ago a resolving-tank was constructed, in which resolution of the organic solids was being carried out, and we have no doubt that, as an analysis attached to [their] paper shows, the excellence of the result is due to the fact that we are dealing really with an effluent which has practically passed through a resolving-tank."

The third, oxidizing or nitrifying, stage, so inefficiently carried out in many systems, first attained a rapid and vigorous operation in the trays of Scott-Moncrieff. By using a series of small separate areas, and passing the effluent from his bacterial tank (Figs. 15 and 16) successively through them, with ample access of air where it is required, the organisms gradually choose their own conditions, and allied groups gather together at different levels as coatings on the filtering material. In my analyses I found that the upper sections were actively engaged in effecting the second stage of purification, whereas in the later ones the nitrifying organisms were almost alone, and, therefore, able to exert their full activity.

The tank effluent is spread by "tipping troughs" or distributors over the uppermost of a series of nine perforated trays supported vertically over one another at about 3 in. apart, each containing a layer of about 7 in. of coke broken to 1 in. diameter. The passage of the liquid through this apparatus is very rapid, and is, of course, continuous, while the results in oxidation and nitrification are extraor-

dinary, showing the advantage of differentiated colonies, and abundance of air supply in the final stage. This is diagrammatically shown in Fig. 18 which summarizes results obtained by me at Ashtead in the early part of last year.

An important point which necessarily follows from the above considerations is that the liquid to be dealt with in such an aërating filter must contain the minimum amount of organic nitrogen or, in other words, its conversion into ammonia must have preceded the processes of oxidation. In effective filters the amount of nitric nitrogen produced should be equivalent to the amount of ammoniacal nitrogen supplied to the bed, and, if worked continuously and well aërated, the organic nitrogen as measured by the albuminised ammonia will be little affected at this stage of the purification. The loss of nitrogen which takes place through secondary changes in the different steps of purification is an interesting study, which must modify the results but which would take too long to discuss in the present paper.

I suppose that at the present time even a sewage article is not complete without some allusion to South Africa.

Among those who were first impressed by the efficiency of the bacterial system was a Mr. A. W. Ackermann, an engineer at the Cape, who, having seen one or two of Mr. Scott-Moncrieff's tanks at work in England, returned with all the information he could obtain, and has since become the pioneer of this system for the Cape Colony. There is no doubt that the conditions prevailing there present considerable difficulties as compared with countries where the water supply is more ample. On the other hand the interference of frost does not exist. Curiously enough there seems to be a strong local prejudice against the use of any sewage for the purposes of cultivation, and I am informed that Dr. Turner, medical officer of health for the Colony, is one of the very few who utilises his sewage for irrigating his garden. The most extraordinary methods are in vogue, and in some places they have gone so far as to excavate the rock into tanks, which are filled with almost solid excreta. In Cape Town

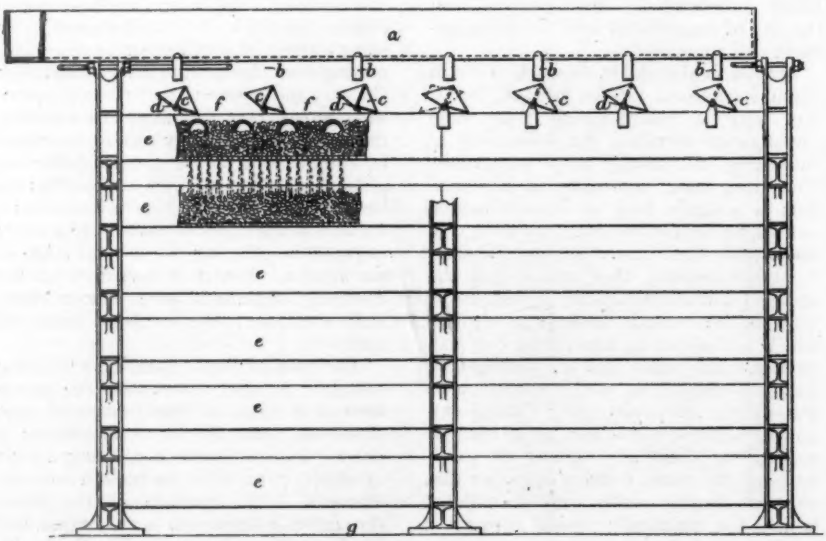


FIG. 17.—SCOTT-MONCRIEFF FILTERING TRAYS, SHOWING TIPPERS FOR DISTRIBUTING THE HYDROLIZED SEWAGE.

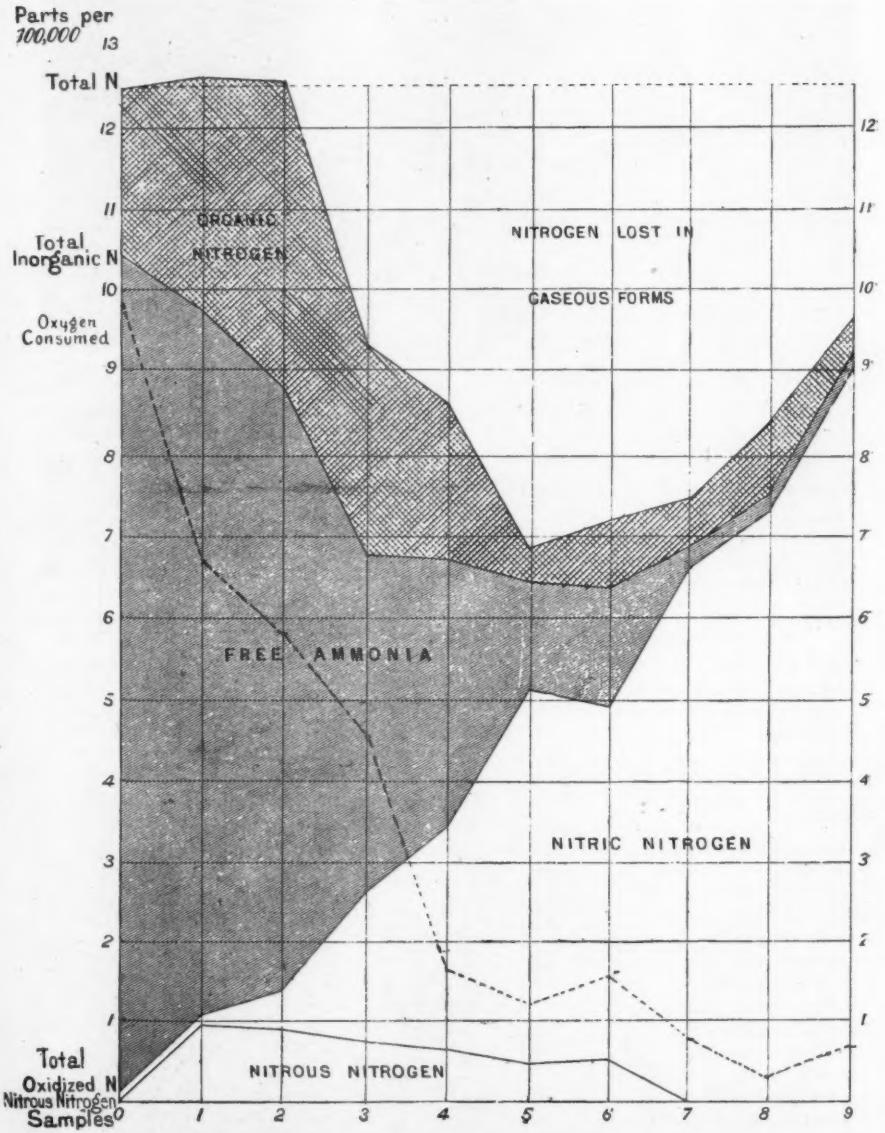


FIG. 18.—PURIFICATION EFFECTED BY SCOTT-MONCRIEFF FILTER TRAYS (THE ANALYSIS OF THE HYDROLISED SEWAGE IS SHOWN ON THE LEFT, AND ITS QUALITY IMPROVES AS IT PASSES THROUGH THE SUCCESSIVE NINE FILTER TRAYS).

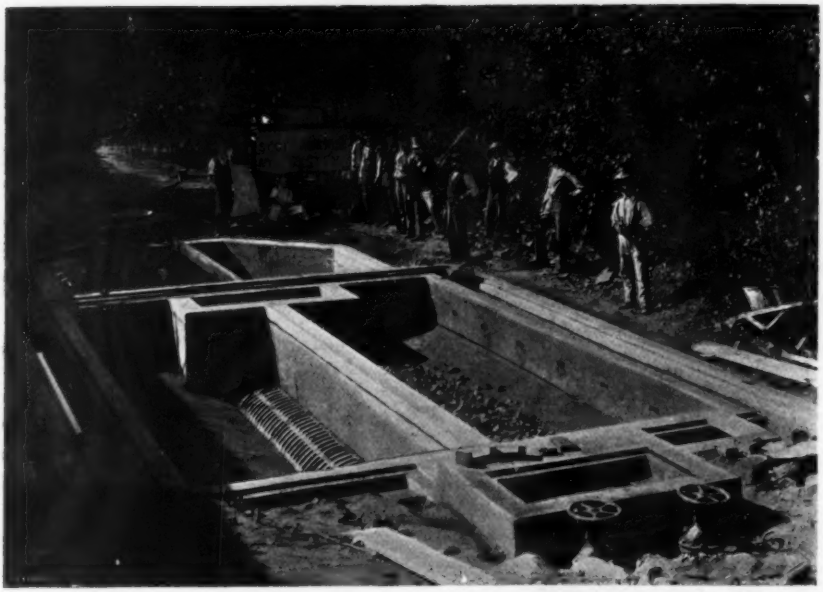


FIG. 19.—SCOTT-MONCRIEFF INSTALLATION AT GROOTE SCHUUR (THE RIGHT HON. CECIL RHODES'S COUNTRY HOUSE).

itself more ordinary conditions prevail, and there is a strong body of opinion in favour of the adoption of the bacterial treatment for the town.

Fig. 19 is a photograph of the installation just completed at the country house of the Right Hon. Cecil Rhodes, at Groote Schuur. It is almost entirely of concrete, and deals with 3,000 gallons of sewage per 24 hours. This is an example of the system as adapted to local requirements. Fig. 20 is from a photograph of larger works at Matjesfontein, taken before filling, lately erected there for the railway station. I understand that the Cape Government are having the system applied to other stations on their railways.

In England the Caterham Barracks installation has now been at work for over twelve months. It was put down to deal with the entire sewage of the barracks, for the War Office, and is a most interesting illustration of how bacterial treatment may be employed with an exceptionally strong sewage. The entire clear area occupied is about 200 sq. yds., the cultivation tank being 42 by 20 ft., and the nitrifying trays having practically the same area.

Provision is made against frost by enclosing the filter house within brick walls, with a concrete roof. Probably the work which is being performed approaches to the limits of the process as regards strength of sewage unaided by any dilution, and when it is stated that something like 2,000 lbs. of butcher's meat are consumed every day, and that to obtain a completely successful result the nitrogen contained in this must first of all be entirely broken up by the anaerobic fermentation, either into a gaseous form, or into nitrogen as free ammonia, it may readily be understood how rapid and active the process must be. As much as 35 parts of free ammonia per 100,000 have been found in the hydrolysed sewage, and over 29 parts of nitric nitrogen have been obtained from the trays. I have never before experienced such large figures from nitrification.

The Caterham plant is also instructive

from an agricultural point of view, because a small sewage farm, almost sterile, on account of the chalk forming nearly the entire surface, lies with a very steep slope immediately below. Before the apparatus was put to work, the crude sewage, partly strained, was passed over this land with small manurial effect, but occasioning constant complaint on the score of nuisance. Such a soil is excellent for the purpose of absorbing an excess of liquid, but is not an active medium for dealing with crude sewage as manure. Now the farmer, looking at the thing from a rough practical point of view, is anxious to obtain the sewage at all stages of treatment, and would be glad to take a much larger quantity than is supplied, as the effluent is clear and odourless, while the vegetation where the effluent is applied is luxuriant.

The Birmingham, Tame and Rea District Drainage Board have recently selected a cultivation tank for a trial on the same scale as that at Caterham Barracks, and propose to take the effluents from this installation over several different kinds of filters, including the coal filter of Mr. Garfield.

FIG. 20.—SCOTT-MONCRIEFF INSTALLATION AT MATJESFONTEIN STATION, CAPE COLONY

This article will not be complete without some reference to the problem of dealing with manufacturing refuse.

This subject is continually cropping up, and the inspectors of the Local Government Board, at the various enquiries throughout the country, usually make most searching enquiries as to its amount in relation to the volume of domestic sewage dealt with. Many authorities refuse to admit manufacturing refuse into the sewers without preliminary treatment, and the definition of sewage in the West Riding in the Act for 1894 includes "unpurified urine, excrementitious matter, and liquid refuse of any house or premises, blood, and the washings of the slaughter-houses, containing urinary or fæcal matter," but does not include "any liquid rendered poisonous, noxious, or polluted in the course of some manufacturing process." Some idea of the amount of manufacturing refuse finding its way into the sewers may be arrived at from gaugings for the volume of sewage at the outfall, or even from the water supply of the town, as the quantity of water required per head per day for domestic purposes is not more than 12 to 15 gals. in rural districts, and in towns with modern water-closets and public baths, 20 gals. may be regarded as a normal quantity. When the water supply of the town exceeds this amount, the balance is used for other purposes, and must be divided between the quantity consumed for manufacturing and that used for public purposes, such as fire-extinguishing, road-watering, &c. In those cases where

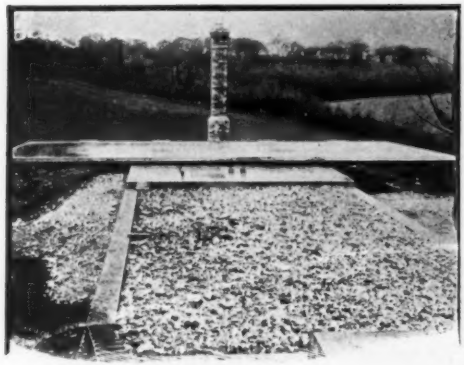


FIG. 21.—CATERHAM BARRACKS.
SCOTT-MONCRIEFF SYSTEM.

the town has a separate surface drainage, gaugings of the dry weather flow will enable one to arrive at the quantity of manufacturing liquid mixed with the sewage under normal conditions, and in very few cases will it be found to represent a large proportion of the total flow. This being the case, it is not a question of the strength or character of any particular trade effluent in a district, but rather the amount of constituents of such effluent in the daily total volume of sewage, which has to be ascertained before arriving at the conclusion whether or no it is likely to have an injurious effect upon a bacterial process. When settling tanks, or anaerobic chambers, are provided to deal with the normal daily volume of sewage, it necessarily follows, that before the sewage reaches the filters, the smoothing effect already referred to will have caused any small quantities of strong manufacturing refuse to be diluted with the total water supply for the day, and I have found it exceedingly difficult to even detect the presence of manufacturing refuse in sewage so diluted.

Thus at Yeovil, the presence of arsenic in the sewage at the outfall is practically insignificant, and at Manchester the experts engaged by the Corporation have only detected indications of manufacturing pollution without venturing to fix any figure to the small quantity which they have found, while with Bradford sewage I have obtained nitrification without special previous chemical treatment. Even in some towns like Wolverhampton or West Bromwich, where an acid liquor derived from galvanising works is the chief trade effluent which reaches the outfall with the domestic flow, the average sewage is not markedly acid in composition. With regard to acid liquors, it must be also recollected that the alkalinity of sewage itself is considerable, due not only to the ammonia produced, but also to the normal discharge of alkaline soaps, and that such alkalinity would necessitate an almost phenomenal quantity of acid trade liquor to change the reaction of the average sewage. At the Exeter enquiry it was suggested that the discharge from the tan-yards might have an injurious effect upon the system, but on calculating, I found that the quantity discharged would have practically the same effect as an additional cup of tea per head of the population two days a week. It must also not be forgotten that the most objectionable forms of trade refuse, from a nuisance point of view, have been those derived from brewing, distilling, paper-

FIG. 22.—CATERHAM BARRACKS.
SCOTT-MONCRIEFF SYSTEM.

FIG. 23.—SEPTIC TANK (EXPERIMENTAL INSTALLATION), DEALING WITH ARSENICAL SEWAGE, AT YEOVIL.

making, and other industries, which yield partially decomposed organic compounds, and it is just these particular compounds which the bacteria in the anaerobic tanks regard as their legitimate food supply. In Scotland the difficulties attending the discharge of "pot-ale" are well known, but Messrs. Dibdin and Thudichum at the Southampton Congress assured us that it had become amenable to bacterial treatment. As Dr. Percy Frankland said in his address, "sewage purification is really a fermentation industry, ranking with brewing," and there can be no doubt that purification can be definitely assured in this manner.

FIG. 24.—MESSRS. WAKE AND HOLLIS' SEPARATING PLANT FOR GRADING FILTERING MATERIAL.

It must not be supposed that any one of the bacterial schemes to which I have alluded can be properly carried out without considerable expenditure. There is, however, not a shadow of a doubt that precipitation, involving a heavy annual outlay for chemicals, and the cost of sludge pressing or carriage, is a thing of the past. In some quarters the idea of pipe-lines, to convey the sewage direct into tidal waters, has been revived, owing to the action taken by Boston and Baltimore in the States, and the figures given at the Manchester inquiry as to the cost of bacterial treatment. Prof. Kennicutt, at Southampton, however, assured the Congress that the Massachusetts Board are continuing their valuable work on bacterial lines, and in this country the further removal of large volumes of water which, if bacterially purified, could be utilised in our depleted rivers and canals, will obviously be seriously contested.

With regard to the economic aspect

of bacterial processes, the utilisation of the gas produced in the first stage has already been described, while effluents freed from suspended matter and rich in nitrates may, as pointed out by Mr. Pidgeon, after all have a manurial value which the failures of the last twenty years have led us to regard as improbable.

As already pointed out, the size of the material used in a filter bed seems to be far more important than the kind of material. Coke breeze, although used very largely, is somewhat expensive when required in large quantities in many localities, and, therefore, local material when properly screened and graded, is to be preferred. In the Midlands, the enormous quantities of waste material in the neighbourhood of various collieries and ironworks have recently been utilised for the recovery of the tap-cinder which they contain, and Messrs. Wake & Hollis, of Darlington, have devised (Fig. 24) improved separating plant for screening this waste material, not only into tap-cinder, but into coke-breeze, clinker, broken bricks, and carbonaceous iron sand. The broken bricks are then available for concrete making, and the other materials are now being screened and graded for the purpose of sewage and water filtration. At Spennymoor, filter beds made of carbonaceous iron sand have been dealing with the district sewage for the past twelve-months, and the results are said to be very satisfactory. These materials being practically waste products, can be put on the market at much lower prices than coke-breeze and other well known materials, and as they exist in practically unlimited quantites, may eventually come into general use.

The great difficulty in working beds of large-grained porous material is to prevent the liquid from passing unequally through the bed, avoiding stagnant sides or corners, or streaming rapidly through channels so as almost to escape the action. Among the many devices for even distribution is the Candy-Caink "self-

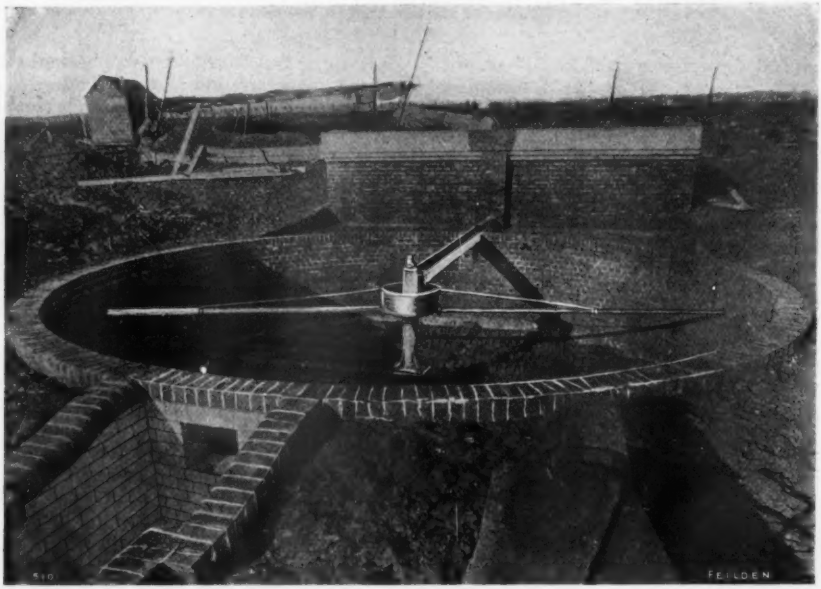


FIG. 24.—CANDY-CAINK SPRINKLER BEFORE THE BED IS FILLED.

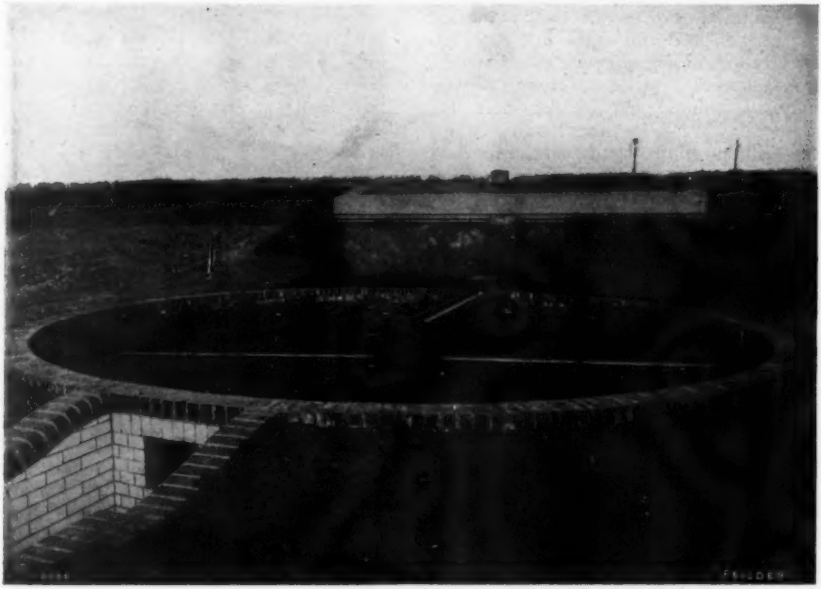


FIG. 26.—COMPLETED BACTERIAL BED, CANDY-CAINK SYSTEM.

propelled revolving sprinkler and aërator" (Figs. 25 and 26) of the International Purification Syndicate. This company have installations at Reigate, Southampton, and Southwold, on principles identical with those of Cameron at Exeter, and Scott-Moncrieff at Caterham, but I have not yet had an opportunity of examining the process in any detail. An "anaerobic sludge-digesting bed" of large stones or clinkers discharges *continuously*, by means of the sprinklers on aërating beds. The continuous action is on the right principle, as I have often emphasised the disadvantage of intermittent working in alternating and confusing the bacterial actions. At the same time the company follow the same selective process as Sutton, discarding "small sticks, large pieces of paper, fat, fæces, and such large matters," the very substances which anaerobic treatment is adapted to deal with. This will probably explain their preference for "all-aerobic beds," and their undervaluing the presence of nitrates.

Samuel Rideal

Feed-Water Heaters.

By GEORGE HALLIDAY, WHITWORTH SCHOLAR.

MR. GEORGE HALLIDAY studied Science at Anderson's College, Glasgow, and at the Royal College of Science, where he gained a Whitworth Scholarship. He acted as chief of the Drawing and Mechanism Department under Professor Perry at the Finsbury Technical College, and afterwards became Professor in Engineering at the Hartley Institution, Southampton. He is the author of "Steam Boilers," the first of the series of Arnold's Practical Science Manuals, and other technical works. He is a Member of the Physical Society, the Institution of Engineers and Shipbuilders in Scotland, and the Institute of Marine Engineers. Of the last he is convener of the Experimental Committee. Has read papers on water-tube boilers, feed-water heaters, etc., and some original papers giving the results of experiments in Physical Science. He proved the increased efficiency of the live steam feed-water heater was due to circulation. Mr. Halliday is now doing special work in connection with water-tube boilers.

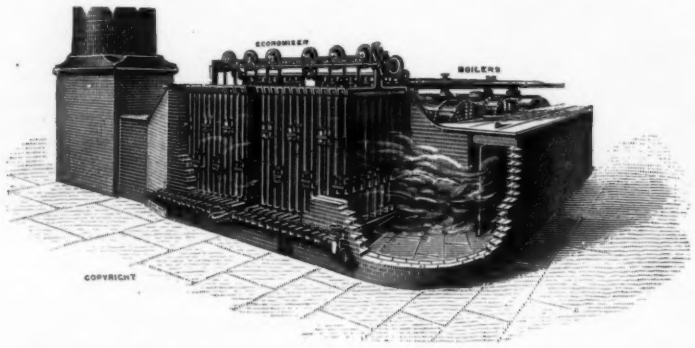
THE problem presented to the engineer as far as an engine and boiler are concerned is to obtain work out of them. He is given so much fuel representing so much heat, and it is his business to change that heat into work in the most economical and expeditious way possible. The heat which is converted into work is in the steam, and the quantity of heat converted into work is measured by two things, the quantity of steam used and its limits of temperature during the change. The higher limit of temperature during the operation is the temperature of the steam in the boiler, and the lower limit is the temperature of the condenser. When the engine is noncondensing, the lower limit is that of the steam as it issues to the atmosphere. In the case of the condensing engine, the water from which the steam is made has to be raised from the temperature of the condenser to that of the steam, and in the case of the non-condensing engine, the water has to be raised from the temperature of the atmosphere to that of the steam. The fluid which receives the heat and gives up the heat is called by engineers the working stuff. When the stuff during the operation is reduced in temperature from that of boiler steam to that of the condenser it gives up heat, and that heat is converted into work. The heat converted into work is only a small fraction of the heat used to heat up the working stuff. It is the business of the engineer to give as much as possible of the total heat which comes from the coal during the cycle of operations to the working stuff. It is also the business of the engineer to use the heat which has been got into the working stuff in the most economical way possible. So we hear of only 13 lbs. and 12 lbs., and of even less steam than that being required by an engine per indicated horse-power. But that is another problem. The problem we have now to deal with is to obtain the

most possible heat taken from the coal into the working stuff.

The quantity of heat which can be taken from the coal and got into the working stuff will depend greatly on the design of the boiler and on the way in which the fuel and fire are treated, and on the temperature at which the feed-water is delivered into the boiler. Should the feed-water be pumped into the boiler at the temperature of the condenser or atmosphere there will not be so much heat got into the stuff in the same time as there would be were it pumped in at a temperature near that of the steam.

3rd. The water is heated with exhaust steam.
4th. The water is heated with exhaust and live steam.
5th. The water is heated with live steam.

Mr. Druitt Halpin had some trouble with an electric lighting plant. As the duty of the plant rose with the increase in the number of lights, he found that the battery of boilers were insufficient to supply enough steam. So he adopted the plan of using the boilers to heat the water during the day time, and this water so heated he



MESSRS. GREEN'S FEED HEATER: TYPE IN WHICH WASTE GASES ARE UTILISED FOR HEATING FEED-WATER.

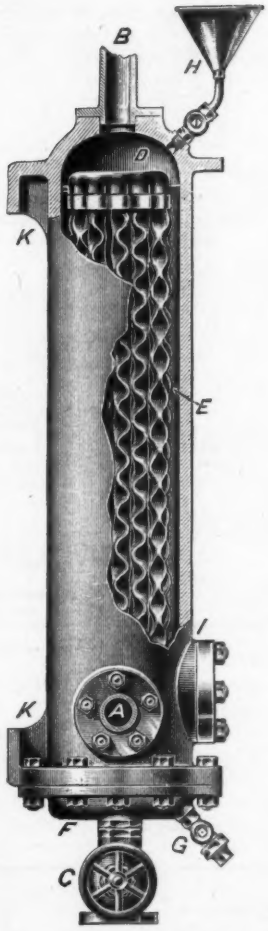
Knowing this from experience, engineers mostly divide the operation of giving heat to the working stuff into two parts. The first part is heating the feed-water to about the temperature of the steam; the second part boiling the water in the boiler and making steam. It is with the first operation we have to deal.

Apparatus used for raising the feed-water to a temperature as nearly as possible to that of steam, are called feed-water heaters or economisers. There are various methods employed to do this, and these are given below.

1st. The water is heated with a separate fire.
2nd. The water is heated with waste gases.

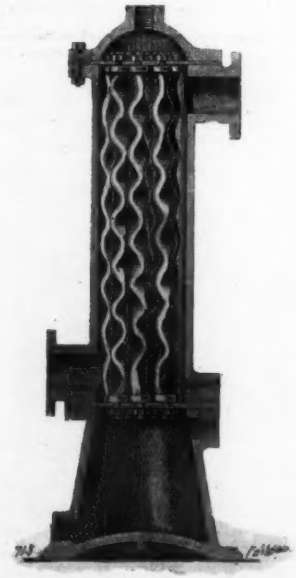
stored in a tank to be used as feed-water for the boilers in the evening. He did not expect any saving. The exigencies of the situation forced him to adopt this plan. One day he gave instructions to find out the economy or want of economy of the system. His assistants found this thermal storage plant gave an economy of 16 per cent. Professor Unwin found, on trial, that the economy was 19 per cent. This higher efficiency was obtained by heating the feed-water by means of a separate fire.

Sir Edward Green uses the second method for heating the feed-water. His method embraces two economies. He not only obtains the advantages of heating the feed-water separately before it is pumped into the boiler, but he obtains the further advantage of extracting more



MESSRS. ROYLE'S FEED HEATER WITH ROW TUBES: TYPE OF FEED HEATER WHICH USES EXHAUST STEAM

heat out of the gases before they are finally discharged into the chimney. Sir Edward places his feed-water heater in the flue between the boiler and the chimney. This feed-water heater is shown in perspective in the accompanying illustration. It consists of a set of cast-iron tubes about 4 inches in diameter by 9 feet in length, made in sections of various widths to suit the convenience of the boiler plants, and set vertically in parallel rows to afford facility for inspection. It is situated in a bye-pass of the main flue; it may be cut off by a damper to allow of inspection without interfering with the work of the boilers. The water inlet is at the bottom, and the water flows up the pipes and out of the feed-water heater at the end next the boiler. The water then comes into the tubes where the gases leave the heater and leaves where the gases come in. There is a blow-off valve in the lower branch pipe opposite the feed inlet, and a safety valve in the upper branch pipe at the end opposite the outlet. Each tube is provided with a scraper which is made to travel slowly and continuously up and down to keep the surface of the tube clear of soot. These scrapers are grouped together so that those adjoining sections of tubes form a single set which is balanced by the set on the next two sections of tubes. From reports sent in to this firm by users



ANOTHER TYPE OF "ROYLE" FEED-WATER HEATER (SECTION)

of the economiser, the saving by its use ranges from 12 to 23 per cent.

Here is a typical test of an economiser:—

ECONOMISER—Working one day of nine hours.
ECONOMISER—Not working one day of ten hours.

TEMPERATURES IN DEGREES FAHRENHEIT.	Economiser Off. MEAN TEMPERATURES, &c.	Economiser On. MEAN TEMPERATURES, &c.
Waste Heat—Temperature of Gases being *last* from Boilers, *without* Economiser (entering Chimney)	448 deg.	.....
Waste Heat—Entering Economiser	.....	448 deg.
Waste Heat—Leaving Economiser (entering Chimney) ...	.....	186 deg.
Steam Pressure in Boilers	93 lbs.	98 lbs.
Sensible Heat of Steam in Boilers	322 deg.	326 deg.
Vacuum in Engine	25·4 in.	25·2 in.
Horse-Power of Engine *indicated*	540 I.H.P.	559 I.H.P.
Duration of Trial	10 hours	9 hours
Coal—Net Weight required	16,611 lbs.	11,000 lbs.
Coal—Per indicated Horse-Power per hour	2·96 lbs.	3·28 lbs.
Coal—Saved by Economiser per hour	.....	.....
Water—Temperature of Feed *without* Economiser	**93** deg.	.....
Water—Temperature *entering* Economiser	.....	.....
Water—Temperature *leaving* Economiser	.....	**229** deg.
RATE OF SAVING BY FUEL ECONOMISER	.....	**23 per cent.**

Mr. Yarrow sent the feed-water into his water-tube boilers in different ways, and the results of his experiments were very remarkable. In the bottom water-drum he placed a division plate, which separated the space for the water into two parts. This division plate was so arranged that the three back rows of tubes were separated from the other rows of tubes, and the water under the three back rows was separated from the water under the other rows. Into the space under the three back rows of tubes Mr. Yarrow forced the feed-water, and before this feed-water could take part in the general circulation of the boiler it had to flow up through the back three rows of tubes.

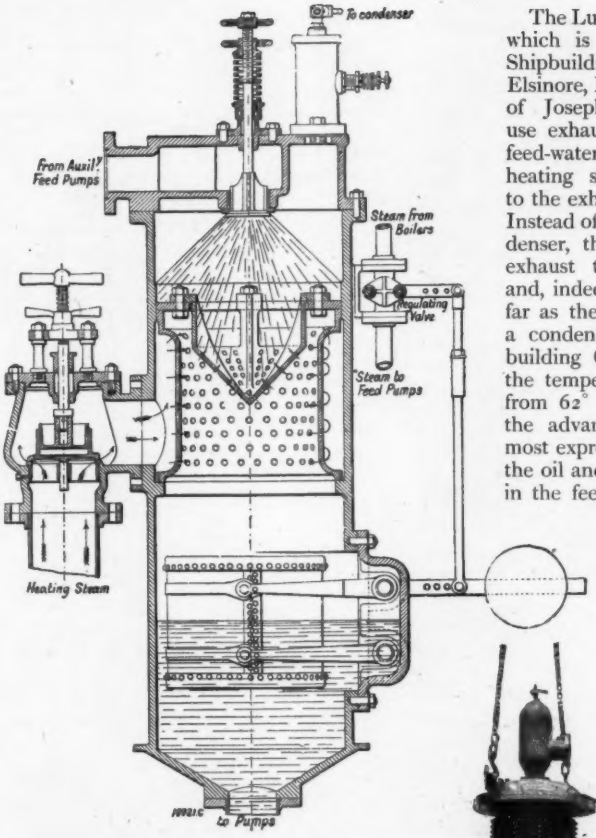
The hot gases from the fire had to flow through amongst the tubes, reaching, of course, the three back rows before they went up the chimney. It was found that the temperature of the hot gases just after they left the last tubes was much lower when the feed-water was made to go first up the back rows than it was when the water was forced in and immediately took part in the general circulation of the water in the boiler. The result was that much more heat was taken out of the hot gases when part of the boiler was set apart for heating the feed-water and the other part of the boiler was used for evaporating the water than under ordinary conditions.

The following are the results:—

Rate of consumption in lbs. of coal per sq. ft. of grate.	Advantage shown by lower funnel temperature.	Funnel temperature.
52	89 deg.	662 deg.
19	45 deg.	433 deg.
31·4	67 deg.	608 deg.

The middle column shows the number of degrees the funnel gases are lower in temperature when the work of the boiler is separated into two parts—feed-heating and evaporation.

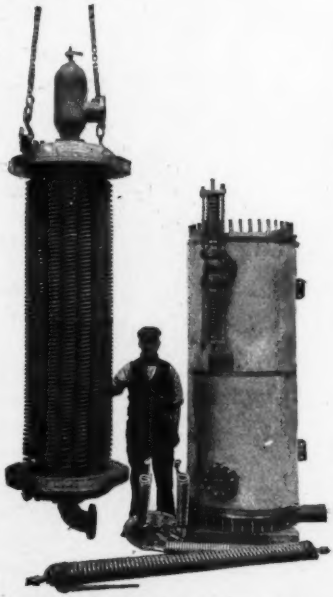
The following table shows the same advantage in another way:—



MESSRS. G. AND J. WEIR'S FEED-WATER HEATER: TYPE USING EXHAUST STEAM AND STEAM ADDED FROM AN INTERMEDIATE RECEIVER.

Water evaporated per sq. ft. of heating surface.	Water evaporated per lb. of coal.	Water evaporated per lb. of coal.
	Without feed-heater.	With feed-heater.
3	10·25	12
4	10·1	11·75
5	10	11·6
6	9·75	11·4
7	9·6	11·2
8	9·5	10·85
9	9·25	10·5
10	8·8	10

The Lundkvist feed-water heater, which is made by the Elsinore Shipbuilding and Engineering Co., Elsinore, Denmark, and some types of Joseph Wright's feed-heaters use exhaust steam for heating the feed-water. On board ship the heating steam would correspond to the exhaust from the auxiliaries. Instead of exhausting into the condenser, the engines are made to exhaust through the feed-heater and, indeed, the feed-heater is, as far as the engines are concerned, a condenser. The Elsinore Shipbuilding Company claim to raise the temperature of the feed-water from 62° Fah. to 180° Fah. But the advantage which they claim most expressly is the separation of the oil and grease from the water in the feed-water heater. Grease



MESSRS. CAIRD AND RAYNER'S LIVE STEAM FEED-WATER HEATER.

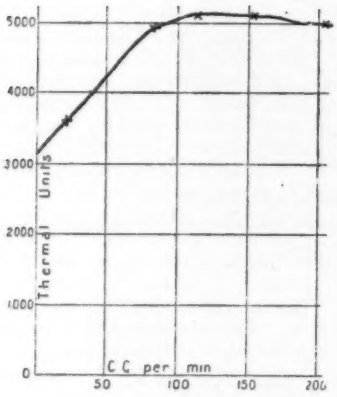


FIG. 1.

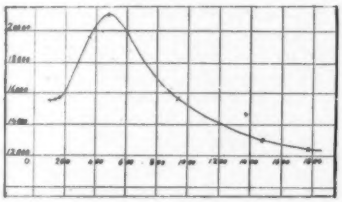


FIG. 2.

DIAGRAMS SHOWING THE RATE AT WHICH HEAT IS ABSORBED BY WATER AS AFFECTED BY ITS VELOCITY THROUGH THE TUBE.

separates out from the water at high temperatures and rises to the surface, where it is skimmed off by means of a skimming spoon let in through the cover.

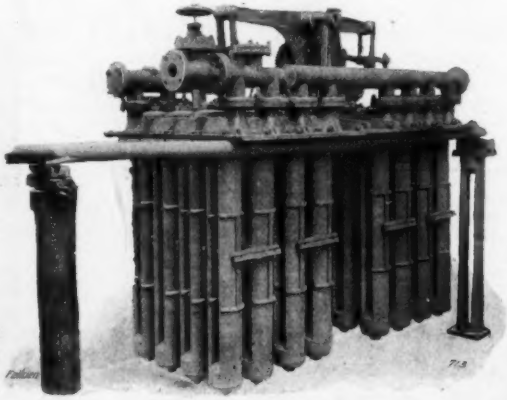
With exhaust steam as a means of heating the feed-water, there are early limits for the temperature to which the feed-water can be raised. For it must not be forgotten that the aim in view is to raise the temperature of the feed-water to a temperature as near that of the water in the boiler as possible. This can only be done remotely with exhaust steam. Mr. Weir improves on this arrangement. He does, indeed, utilise the heat in the exhaust steam from the auxiliary engines, but in order that the feed-water should be delivered to the boiler at a considerable temperature he adds steam from the intermediate receiver. The temperature of the steam in the intermediate receiver is about 290°, and this allows the limit to which the temperature of the feed-water can be raised before it is sent into the boiler. This manner of heating the feed-water is the fourth system in our list.

The following is the result of feed-heating by Mr. Weir's system. The figures are supplied by Messrs. G. & J. Weir.

ECONOMY DUE TO DIRECT CONTACT FEED-HEATING.

Steam from l.p. receiver	25 lbs.
Temperature of hot-well	100° F.
,, of feed with heater on ...	220° F.
Heat units extracted from steam for feed-heating	120
Heat units available in h.p. and l.p. cylinders per lb. of steam ...	1086·6
Heat units available in l.p. cylinder ...	966·6
Heat transferred from steam to feed-water	11·04 %
I.H.P. lost in l.p. cylinder	3·97 %
Net gain by feed-heating	7·07 %

Messrs. Weir have not considered the advantage to the work of the boiler from the separation of feed-heating from the evaporation. The gain shown above is simply the heat saved which would otherwise have been thrown away. The



PIMBLEY'S FEED HEATER, WHICH REGULATES SPEED OF WATER THROUGH THE TUBES.

real gain from the use of the system would be higher than that shown above.

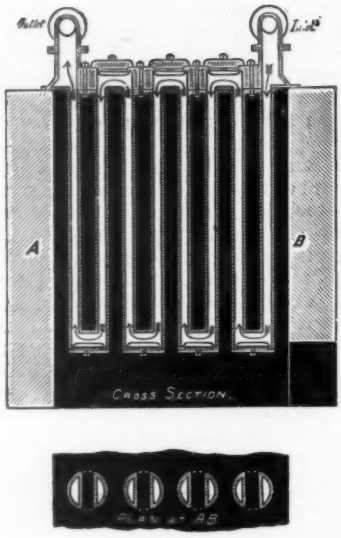
The fifth system is by means of live steam, taken direct from the boiler. Some one has said it is robbing Peter to pay Paul. In view of the old ideas and principles held with respect to the transmission of heat to water, either from steam or from hot gases, it appears absurd to expect that there could be any advantage from this system. But trials of live steam feed-heaters have proved unmistakably that there is an advantage. The classical trial of the feed-heater on board the *Oriole*, a small paddle steamer plying between London, Margate, Ramsgate, Deal, and Dover, showed unmistakably there was a gain by the use of the live steam feed-water heater. In this trial it was found that without the heater 85 lbs. pressure of steam could be maintained with difficulty by the stokers. Under this condition the feed-water was supplied to the boilers without being sent through the feed-heater for three-quarters of an hour. At the end of that time the feed-water was sent through the feed-heater. In about a quarter of an hour the feed rose from 140° to 320°, and the boiler pressure to 97 lbs., and remained there. The revolutions of the engine rose from 34 to 35½ per minute. About a month ago a trial was made of a live steam feed-heater of another type. Before it was fitted on to the steamer, steam could be maintained in the boiler with difficulty. After it was put in use the revolutions rose by 1½ per minute, and the engineer reported easy steaming.

The following table gives the boiler pressure, the temperature of the hot-well, the mean temperature of the feed, also the temperature of the live steam used in the case of Messrs. Caird & Rayner's live steam feed-water heater :—

NAME OF SHIP.	MEAN OF TRIALS.				
	Boiler pressure.	Temperature of steam.	Temperature of hot-well.	Mean temperature of feed.	Highest temperature of feed attained.
Dunvegan Castle	163 lbs.	374°	67°	230°	254°
Tintagel ,, ...	162 ,,	370°	62°	218°	239°
Avondale ,, ...	160 ,,	370°	62°	219°	237°
Dunolly ,, ...	161 ,,	370°	68°	224°	236°
Raglan ,, ...	170 ,,	376°	68°	225°	236°
Braemar ,, ...	193 ,,	384°	65°	230°	260°
Carisbrooke ,, ...	196 ,,	388°	67°	252°	261°

In the case of Mr. Druitt Halpin's system of thermal storage it has been seen that there is a gain of 19 per cent. efficiency. By simply making the production of steam in two operations instead of one there is a large gain. When the waste gases are utilised for heating the feed, and the temperature of the gases finally passing into the chimney are greatly reduced, the source of the gain is very plain and clear. It is also plain and clear that there will be a gain if the exhaust steam from the auxiliary engines is used to heat the feed-water. But it is not so evident that gain will result from the separation of steam making into two operations ; first, the production of boiling water ; and, second, of steam from it. And it is less evident that the use of intermediate casing or live steam will result in a gain. But it has been shown there is, and it will be interesting to know if an explanation can be found for the phenomenon under accepted principles of the transmission and heat-absorbent power of water.

It was thought by French experimenters that water developed new properties just when it burst into the boiling point. It was thought by them that the water took in heat much more rapidly in consequence of more tumultuous motion. It was thought by an English engineer that it was capable of taking in heat more rapidly in consequence of its motivity. As far as one could judge, the idea was that the motion of the particles amongst themselves, the water mixing more rapidly, was the cause of its increase of absorbent power. It had already been proved that an increase in the rate of motion of water over a hot surface was followed by an increase of absorption of heat by the water. As far as one could judge by a description of the



FEED-WATER HEATER WHICH REGULATES THE FLOW OF WATER THROUGH THE TUBES.

experiments made by the French, they had not made them so as to separate the two effects. To determine whether or not water developed new properties just at the boiling point it was necessary to separate the two influences—the influence of the new property from the influence of the more rapid motion over the hot surface caused by the ebullition. When this was done it was found that water absorbed less heat at the boiling point than at temperatures lower than the boiling point. This proved that any increase in absorption was due to the more rapid motion of water across the heating surface. In one case, when the water moving up a vertical tube was delivered at the boiling point, the number of thermal units absorbed by the water per minute was 2740·5, and when it was delivered at a temperature of 197° Fah. the number of thermal units absorbed per minute was 4,314.

But that was not all. The makers of water-tube boilers know that more rapid motion of water over the heating surface is followed by an increase in the rate of absorption, and they came to the conclusion this went on without limit. But there were limits. Experiments showed there was a maximum, and after the maximum was reached there was a falling off in the rate of absorption of heat by the water. Further, with a certain source of heat, and a certain quantity supplied, there was a definite maximum limit of the rate of absorption. Here is a case. In a series of experiments in which water was made to flow through a tube, and steam on the outside of the tube was the heating source, the following were the results:

Cubic centimetres flowing per minute.	Average difference of temperature.	Thermal units transmitted to the water per minute.
36·5	129·4	4,684
77·5	67·8	5,254·5
106·2	51·4	5,458·6
135	40·2	5,427
175	26·2	4,585
205	13·4	2,747

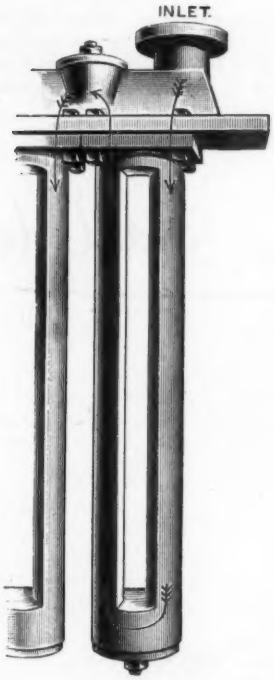
The curve (Fig. 1) representing the thermal units as ordinates and the velocities as abscissæ is given.

With heat supplied by a Fletcher burner to the outside of a copper tube through which water flowed, the results and curves were still more remarkable. Here is one set of the results obtained:—

Cubic centimetres flowing through per minute.	Difference of temperature.	Thermal units absorbed.
120	131·5	15,780
150	105·5	15,825
165	93·5	15,427
320	62	19,840
480	44·5	21,360
920	17·25	15,870
1,500	9	13,500
1,800	7	12,600

The curve (Fig. 2) in the accompanying diagram shows the manner of the change in the absorbent power.

Professor Osborne Reynolds found that when water flowed slowly through a tube, the particles of water flowed in straight and parallel lines, but when the velocity



ONE OF THE SETS OF PIMBLEY TUBES, SHOWING THE DIRECTION IN WHICH THE WATER FLOWS.

of the water increased, the water began to break up and move in swirls across the section. This swirling, eddying motion increased as the velocity increased. It has been thought that this explains the increase of the heat absorbent power of water. There might be something in it if the maximum came always at the same velocity. But the maximum point does not come always at the same velocity, and so this cannot be the whole cause of the increase in heat absorption.

It was also found that heat applied to a tube through which water flowed caused the water to depart from its straight-line motion and become disturbed. Heat, therefore, had the same effect as increased velocity. The intensity and the quantity of the heat supplied from the heating source may be the determining quantities of the maximum disturbance of the water. The velocity of the water, then the intensity and quantity of the heat supplied to the heating surface, causing a rotating motion in the moving fluid, may be the cause of an increasing absorption of heat by the water, and the change of position of the maximum point may be attributed to the variation of each and all of these factors.

It may be assumed that water which comes out of a hose comes out in straight lines; that at high velocities the water loses again its rotational motion and flows again in straight lines. Under such conditions the layer of steam next the heating surface will set up its old resistance to the transmission of heat, and the greater the speed, the greater will be the thickness of this layer. So it may be assumed the absorption of heat by the water when moving at high velocities will gradually fall away from the maximum.

In all machines in which tubes are used for conveying water, and in which heat is supplied to heat the outside of the tubes, the best results will be obtained where the speed of the water suits the external source of heat. The maximum transmission will be obtained by the regulation of this speed so as to obtain the maximum transmission per square foot of surface. The length of the tube will determine the final temperature.

There are many practical considerations to be considered in the construction of feed-water heaters. Grease and impurities have to be taken away, and the machine must be so constructed as to allow of this being readily done.

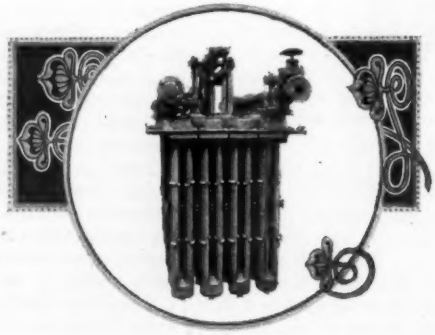
The design and construction of a feed-water heater must be made to embrace all the factors which influence the most efficient way of conveying heat to the feed-water, and of purifying it at the same time.

That being the case, a feed-heater cannot be properly designed which does not arrange for the water moving through the tubes at its best rate.

In many feed-heaters the arrangement is simply to have the water around the tubes. The speed at which the water runs over the heating surface is not considered.

However good this arrangement may be for obtaining an excellent separation of the oil and grease from the water, it cannot be said to be a good arrangement for the economical use of the heat or of the heating surface. That design will be best which provides for the most economical use of heating surface, heat available, and for the separation of the grease from the water.

Geo. Halliday



Modern Appliances in Gas Manufacture.

By FLETCHER W. STEVENSON, M.I.C.E.

(Continued from page 40.)

In previous articles the appliances have been described for discharging coal, and for charging and drawing both horizontal and inclined retorts, and economically handling the coke resulting from carbonising coal. It is now proposed to describe some of the appliances in use for the processes through which coal gas has to pass before it is distributed to consumers.

CONDENSERS.

It is necessary before coal gas can be freed from impurities that it should be cooled to a temperature, varying with climatic conditions from about 50° to 70° F. In the earlier days of gas-making this was done by simply passing the gas through a series of cast-iron pipes placed either vertically or horizontally and exposed to all changes of the atmosphere, very little notice being taken of the temperature to which it was reduced. It is now generally recognised that though a fixed temperature cannot be taken as universally applicable in summer and winter yet it is very necessary to keep within a certain range, and for this purpose a ready means of regulation is necessary. This undoubtedly can best be obtained by the use of water.

One of the earliest types of water condensers will be found at the Old Kent Road Works of the South Metropolitan

FIG. 28.—WATER CONDENSERS AT THE OLD KENT ROAD STATION, SOUTH METROPOLITAN GAS CO.

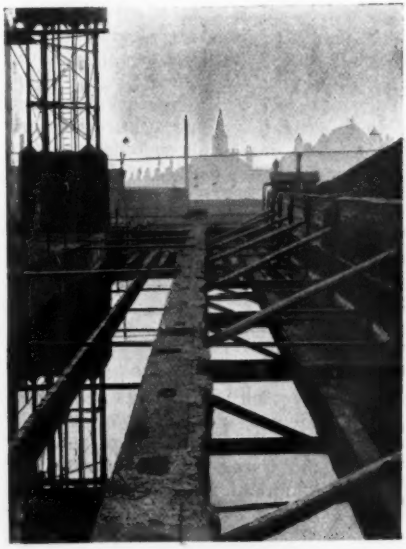


FIG. 29.—WATER CONDENSERS AT THE OLD KENT ROAD STATION SOUTH METROPOLITAN GAS CO.

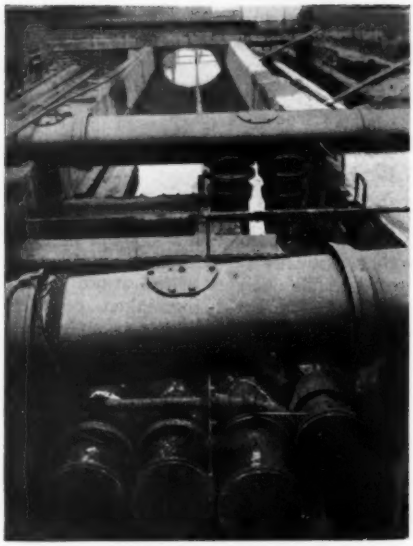


FIG. 30.—WATER CONDENSERS AT THE OLD KENT ROAD STATION, SOUTH METROPOLITAN GAS CO

Gas Company, where Mr. George Livesey adopted large-sized cast-iron pipes laid in a shallow open brick tank (Figs. 28-31.) The pipes are laid in straight parallel lines. Between each line is built a brick division, a waterway being left through the divisions at alternate ends. Cold water is admitted at the end where the gas leaves the tank and flows in the opposite direction to that of the gas, so that no sudden chill is experienced by the gas, and the cooling operation is gradual and even throughout.

This form of condenser, however effective, requires considerable ground space for the necessary surface contact with the water.

A very efficient self-contained water-tube condenser, and one occupying very little ground space, is that patented by Morris and Cutler and manufactured by Saml. Cutler and Sons, of Millwall. It consists (Fig. 32) of a cast-iron rectangular box, having vertical divisions forming compartments eight or nine inches wide, with the divisions being stopped short at alternate ends to leave room for the passage of the gas, which in this way is made to travel to and fro several times the length of the apparatus before reaching the outlet. Within these compartments is a number of wrought-iron tubes, each $\frac{3}{4}$ or 1 in. in diameter, placed about 6 in. apart. To prevent the warm gas from rising to the top and stratifying into layers of different temperatures, two or three vertical baffle plates are inserted in each compartment, the gas being made to pass under and over these alternately. Cold water is admitted into the tubes at the end of the compartment at which the gas leaves the condenser, and flowing through them in the opposite direction to the flow of gas, is gradually warmed by absorbing heat from the gas until it finally leaves at the end of the compartment at which the gas enters.

Another condenser of a similar type is that made by Clapham Bros., of Keighley. In this case the condenser (Figs. 33 & 34) usually consists of three towers, each having top and bottom water chambers, separated from the gas by horizontal diaphragm plates,

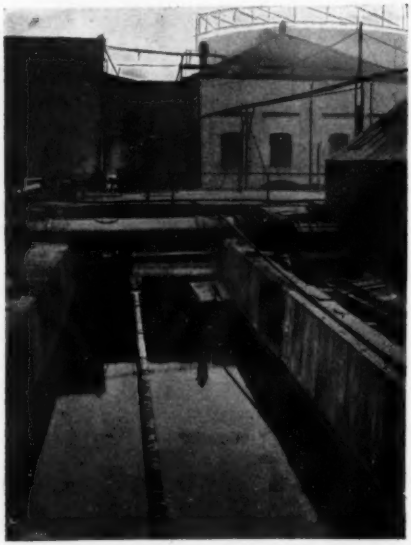


FIG. 31.—WATER CONDENSERS AT THE OLD KENT ROAD STATION, SOUTH METROPOLITAN GAS CO.

perforated for water tubes. The top and bottom chambers are connected by means of a number of 1½-in. diameter vertical tubes, which are firmly secured by back nuts to the lower diaphragm plate, but pass through special glands and stuffing boxes in the top diaphragm plate to allow for expansion and contraction. Any one of these tubes can be taken out and replaced without disturbing any other, and all the tubes can be cleaned with a tube brush from the top, which is open. The gas enters the gas way at top of the first tower, descends to the bottom, and is then conveyed by a diagonal outside pipe to the top of the second tower, and so on to the outlet of the last. The water is admitted at the lower water chamber of the last tower, passes upwards through the tubes into the top water chamber and is then carried downwards by an outside connecting pipe to the bottom water chamber of the second tower, and so on until it flows away hot at the top of the first tower where the gas enters.

With the latter form of condenser, and when using well-water, the author has obtained diagrams showing that the temperature of gas at the outlet has been steadily maintained with only one degree of variation per 24 hours.

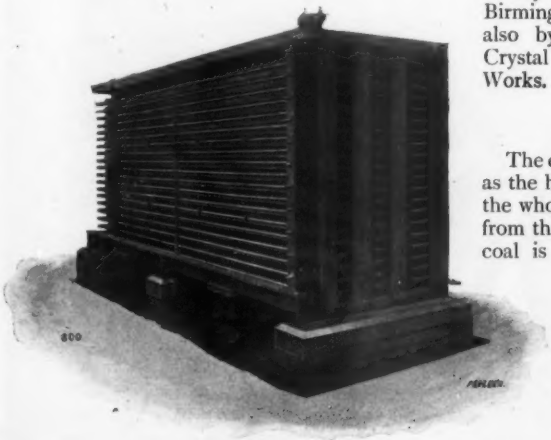


FIG. 32.—MORRIS AND CULTER'S WATER-TUBE CONDENSER, WITH END AND SIDE PLATES REMOVED TO SHOW WATER TUBES: STRATFORD-ON-AVON GAS WORKS.

FIG. 33.—CLAPHAMS' WATER-TUBE CONDENSERS: BRUSSELS GAS WORKS.

A combination where the gas is passed first through atmospheric condensers, and the cooling is finished off in the water-tube type, is probably the most desirable, and this plan has been adopted by Mr. Henry Hack in the new works of the Birmingham Corporation at Saltley, and also by Mr. S. Y. Shonbridge at the Crystal Palace District Gas Company's Works.

EXHAUSTERS.

The exhauster has been rightly described as the heart of a gas works, for if it stops the whole production of gas must cease, from the fact that fireclay retorts, in which coal is distilled, are porous under very slight pressure. It is to draw away the gas and prevent this pressure that an exhauster is necessary.

The exhauster most generally used in gas works is a rotary one invented by Beale in 1848. In the form as improved by Gwynne & Beale, and manufactured by Gwynne & Co., of Brooke Street Works, Holborn,

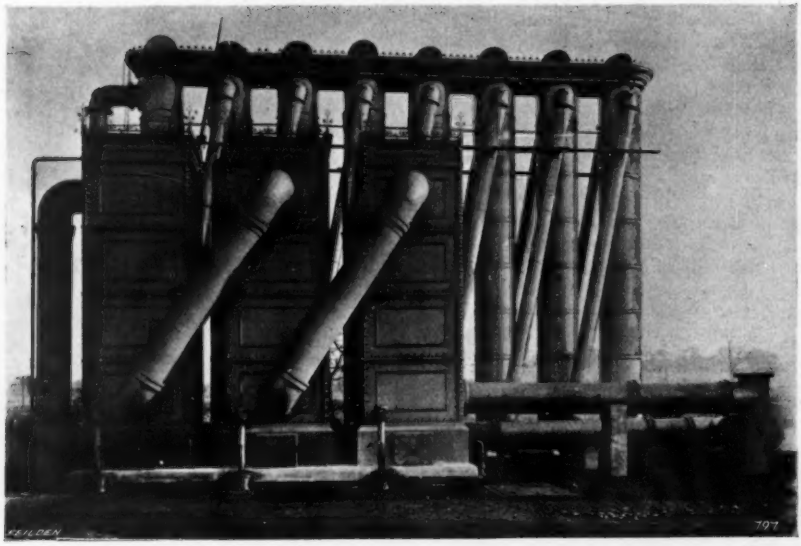


FIG. 34.—CLAPHAMS' WATER-TUBE CONDENSERS AT THE CRYSTAL PALACE DISTRICT GAS CO.'S WORKS.

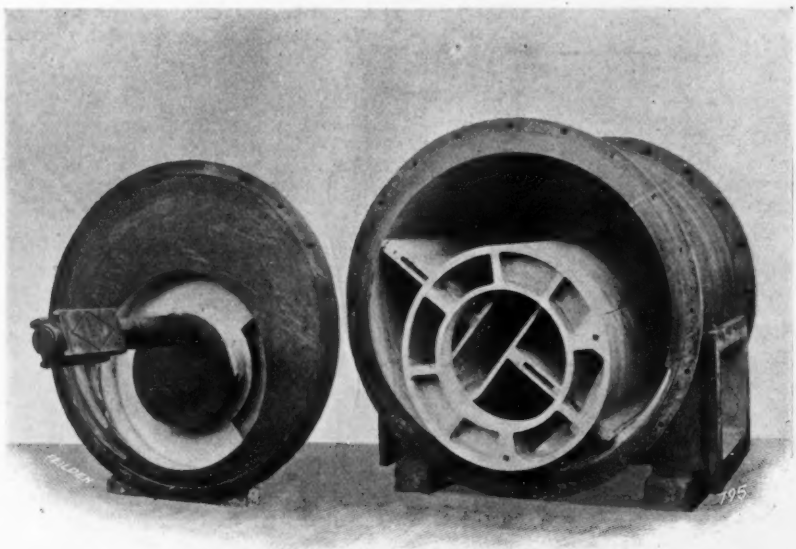


FIG. 35.—DONKIN'S 1892 PATTERN OF EXHAUSTER,
WITH END PLATE REMOVED AND PLACED ALONGSIDE TO SHOW INTERNAL ARRANGEMENT.

it consists of a cast-iron cylindrical case having inlet and outlet branches. Within this case revolves a cast-iron drum of much smaller diameter, having shafts cast on at each end projecting through stuffing boxes in the end plates and carried on outside bearings. At one end the shaft is provided with a pulley or is coupled direct to the crank shaft of an engine, the latter plan being now usually adopted. The drum is fixed parallel but eccentrically to the outer case and touches the bottom of it. Passing through the drum at opposite sides are fitted two blades which, guided by sliding segments running in recesses in the end plates or covers of the outer case, are made to sweep out the latter twice in every revolution. Slips and springs are fitted to the edges of the blades to ensure close contact with the case. The gas being drawn in is carried round the case above the drum and forced out at the other side. A certain percentage of slip with a rotary exhauster is unavoidable, as between the ends of the blades and the outer case, and again between the drum and the bottom of the case there must be contact without any undue friction. It is said that with a clearance $\frac{1}{32}$ of an inch slip occurs of the whole of the gas when working against a pressure equal to 20-in. column of water. It will therefore be understood that the workmanship must be of the very best description to obtain effective duty, especially when working against pressures of 36 to 50 in. which is not unusual in large gas works.

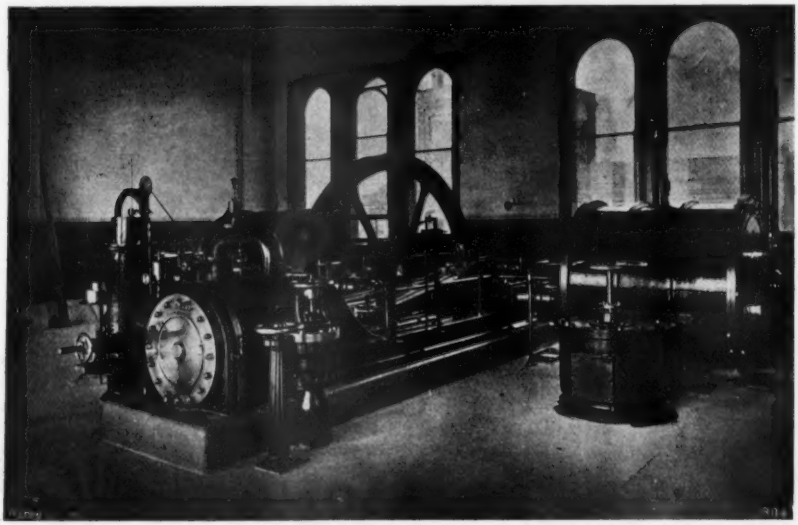


FIG. 36.—PAIR OF DONKIN'S 1887 PATTERN OF EXHAUSTERS: CAPACITY 350,000 CU. FT. PER HOUR EACH: BECKTON WORKS, GAS LIGHT AND COKE CO.

In the form of exhauster just described considerable friction is set up by the segmental slides or rings, which revolve in the recesses of end plates near periphery of the outer case. John Beale's latest type, patented in 1877, and manufactured by B. Donkin & Co., of Southwark Park Road, obviates this by doing away entirely with these slides or rings. In this exhauster the outer case is made elliptic in shape, the width being greater than height; one blade only is used, and to this is cast

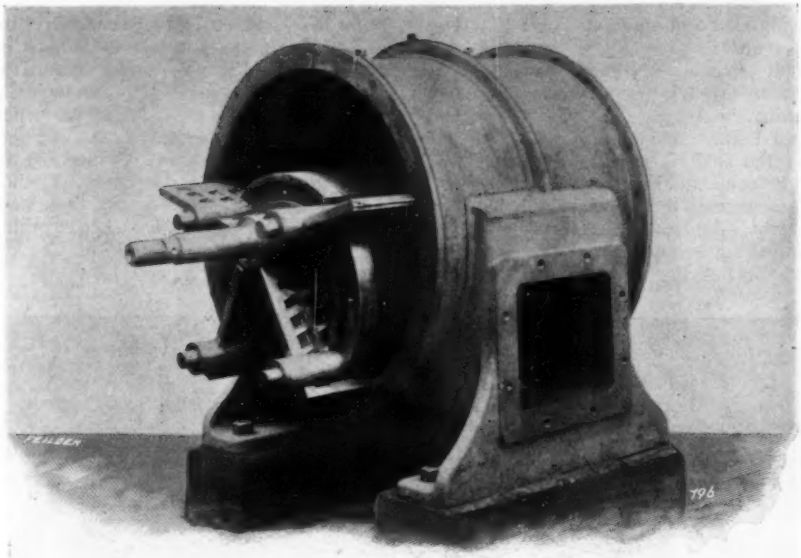


FIG. 37.—WALLER'S PATENT FOUR-BLADE EXHAUSTER, WITH BACK COVER REMOVED AND THE BLADES, ROLLS, AND CENTRE SPINDLE DRAWN SLIGHTLY OUT TO SHOW INTERNAL ARRANGEMENT.

a guide which slides on a simple block in the centre of the exhauster where the velocity, of course, is lowest and friction, therefore, much reduced. The outside bearing on the drum shaft is retained at the end of which the exhauster is driven, but at the other end the drum forms the bearing by being made longer and running in recess in end plate. This type may be run at higher speed, and as the percentage of slip is constant at all speeds a greater proportionate duty is obtained.

Following on this form of exhauster, Mr. E. B. Donkin patented, in 1892, an arrangement for utilising the internal drum and thus further increasing capacity (Fig. 35). By flattening two sides of the interior of the drum and providing projections from the sliding guide (in this case made the full length of the drum), the guide is converted into a piston working to and fro in the drum in a similar manner to the piston of a steam engine. Ports are provided in the end covers, so that when gas is being drawn into the drum at one end it is being forced out at the opposite end. The gain in capacity is claimed to be fully 40 per cent., but against this must be placed the disadvantage that an increased strain is thrown upon the centre block while the gas is being forced out of the drum. On the whole, the author questions the advisability of complicating an exhauster which, it must be remembered, runs continuously day and night usually for some six months in the year with a stop only for a few hours on Sundays.

An exhauster made by George Waller & Co., of London and Stroud, and having four blades instead of two, is now being largely adopted by some engineers (Fig. 37).

The outer case is cylindrical, and is provided with greater clearances to the inlet and outlet ports than usual with other types. The inner drum is prolonged at the ends and carried in recesses in the end plates, while at one end a driving shaft is cast to the drum and projects through a stuffing box in the end plates. Through the centre of the case is

a fixed spindle to which are hinged, and radiate from it, four blades, passing through four small rolls fitted into truly bored holes in the periphery of the inner drum. These rolls have an oscillating motion, to give the necessary movement as the blades open and close in the revolution. A ring bored at equidistant points to take the reduced ends of the small rolls is fitted into the outer end of the inner drum.

The segment guides used in the Gwynne & Beale exhauster are unnecessary in this type, the centre spindle ensuring that the blades are kept in contact with the periphery of the outer case, and friction is therefore considerably reduced.

The exhauster has the advantage over the ordinary two-blade type that while the cubic contents between the blades is less, four deliveries are made per revolution instead of two, giving an increased delivery of somewhere about 50 per cent., and a steadier gauge and more powerful exhaust with the same engine power. On the other hand it has the disadvantage, similarly to Donkin's 1892 pattern, of being complicated and not so suitable for long continuous work as the two-blade type.

It is very necessary that the vacuum formed by the exhauster should be steady and evenly maintained though the quantity of gas produced may vary, as may also the pressure of steam. This was effected in early days, and is still in small works, by a wing throttle valve, so placed as to allow a portion of the gas to return from the outlet to the inlet of the exhauster. This wing valve is actuated by a small gas holder, the inlet vacuum being allowed to act under the crown of the holder. If then an excess of vacuum is created by the exhauster it also acts upon the holder and causes it to sink, and in doing so the throttle valve is opened wider, more gas at once returning to the inlet of the exhauster and so restoring the vacuum to the *statu quo*. Should the vacuum be reduced, the reverse operation occurs, the holder rising and closing the throttle valve

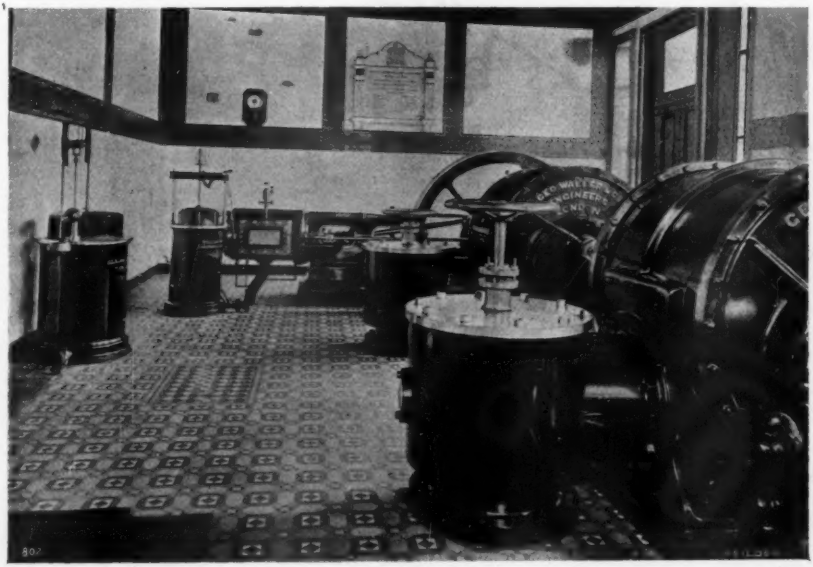


FIG. 38.—PAIR OF WALLER'S FOUR-BLADE EXHAUSTERS AND ENGINES, 150,000 CU. FT PER HOUR EACH, AT THE SWAN STREET GAS WORKS BOLTON.

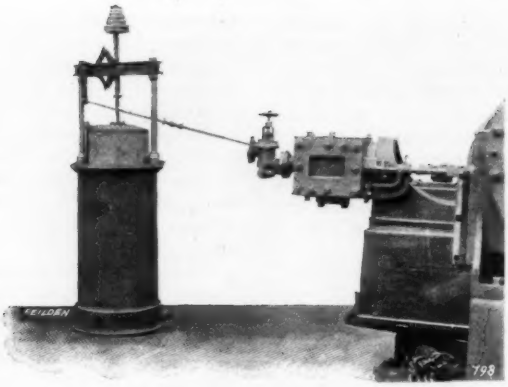


FIG. 39.—WALLER'S PATENT HYDRAULIC GOVERNOR, CONNECTED TO EQUILIBRIUM THROTTLE VALVE ON STEAM ENGINE DRIVING EXHAUSTER.

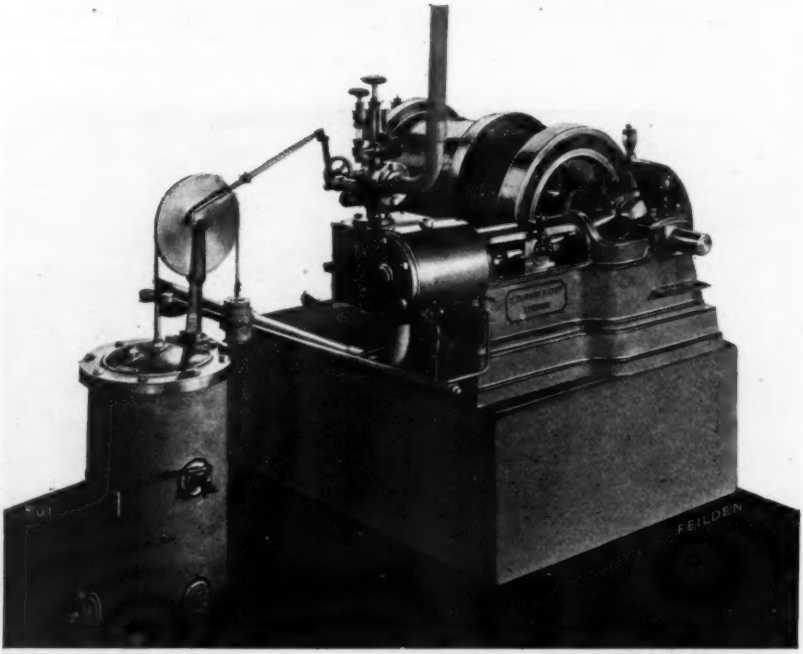


FIG. 40.—DONKIN'S PATENT HYDRAULIC GOVERNOR, ATTACHED TO EQUILIBRIUM THROTTLE VALVE ON STEAM ENGINE DRIVING SMALL EXHAUSTER.

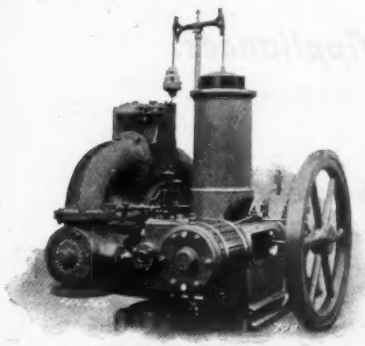


FIG. 41.—WALLER'S SELF-CONTAINED EXHAUSTER, ENGINE, AND COMPENSATING VALVE FOR USE IN SMALL GAS WORKS.

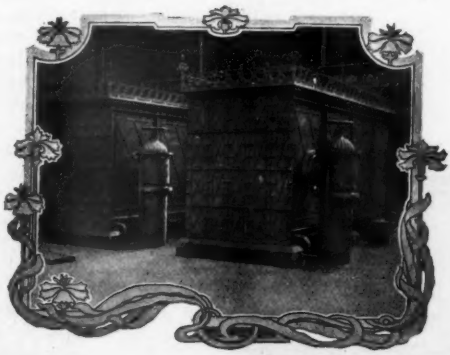
so that less gas is returned to the inlet of the exhauster.

This, as will be seen, is a wasteful procedure, throwing additional work upon the exhauster by churning a portion of the gas over and over again. As long as the exhauster and the engine driving it was small this was of little moment, but as the sizes increased the importance of doing only the necessary amount of work increased also.

The throttle valve was now transferred to the steam engine acted upon in the same manner by a small gas holder, the effect being to increase or decrease the speed of the engine inversely as the vacuum increases or decreases. In details this arrangement has been improved upon by various engineers and makers, until now a very steady gauge can be maintained automatically under considerable variations.

(To be continued.)

Fletcher W. Stevenson



Pneumatic Tools and Appliances.

By EWART C. AMOS, M.I.Mech.E.

PART II.—AIR-COMPRESSORS.

(Continued from page 48.)

In the last article further information was promised in regard to the valve-arrangement of the "Ingersoll" type of compressor, and this can best be described by reference to the illustration (Fig. 14), which clearly shows a section taken through a piston-inlet air-cylinder, in which *E* is the air inlet (through the piston-inlet pipe); *F* the air outlet, the passage to which is governed by the two discharge valves *H H*. *G G* are the piston-inlet valves, and *J* is a water jacket. The other letters of reference indicate parts whose object is apparent. As will be seen at a glance, the two inlet valves are contained in the piston and of course move with it, their area of opening being large. Supposing the piston to be moving from right to left, and, for convenience, call the left-hand side of diagram the front end, and the right side the back end of cylinder. A vacuum will commence to form at the back of piston, and air will at once rush in through *E* into the interior of the piston. (It should be stated that the two valves *G G* open outwards from the piston.) The forward valve *G* will remain closed owing to pressure of air in front of piston, which is then delivering to receiver through forward delivery valve *H* and pipe *F*. The backward valve *G*, however, will open, due to the vacuum referred to, and will continue open till end of stroke when the action is reversed and air is taken into the other side of piston. It will be noted that air supply always comes in through *E*, in whichever direction the piston is moving, as it simply fills the space in the interior of the piston and passes through the valves *G G* into the back or front of piston, according to the direction in which it is moving. In order to secure cool, dry and clean air, it is usual to connect the pipe *E* with the outside atmosphere.

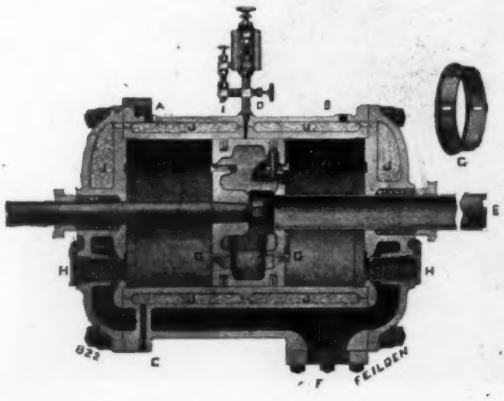


FIG. 14.—SECTIONAL VIEW OF AN "INGERSOLL" PISTON-INLET AIR-CYLINDER.

Some of the smaller sizes of "Ingersoll" compressors are fitted with vertical lift suction and delivery valves, two at top and two at the bottom of cylinder, instead of in the piston and at end of cylinder, but the system described above is preferable.

Reference was also promised in the last article to the method adopted for governing the air supply to a "Curtis" type of compressor. Fig. 15 shows the outside of a valve case and suction chamber with governor of such a compressor; whilst Fig. 16 is a sectional view of same, in which *A* is one of the

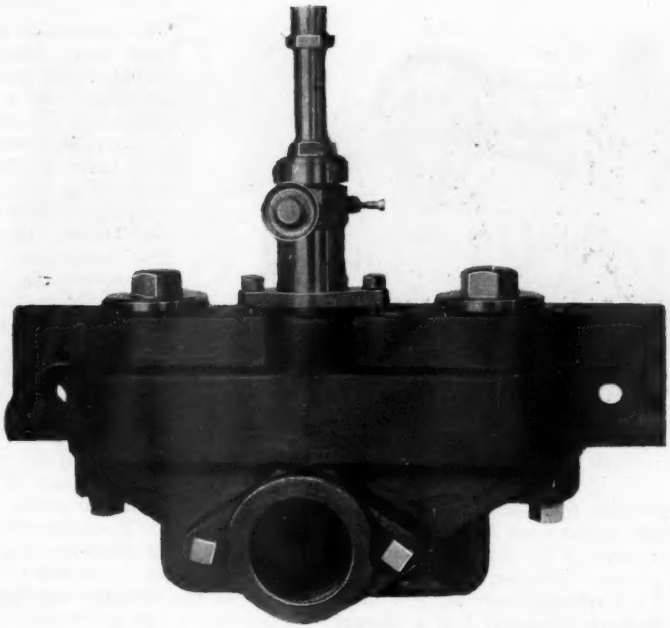


FIG. 15.—VALVE CASE AND SUCTION CHAMBER OF "CURTIS" COMPRESSOR.

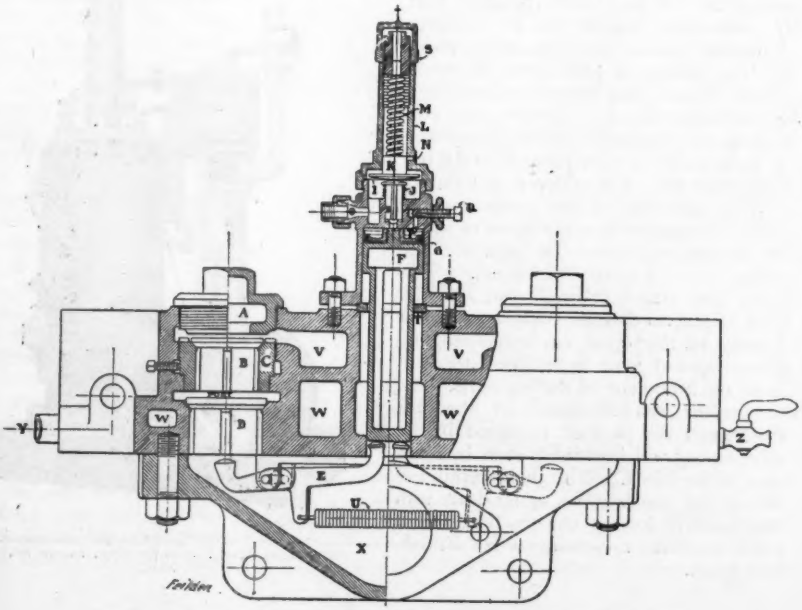


FIG. 16.—SECTION OF VALVE CASE AND SUCTION CHAMBER OF "CURTIS" COMPRESSOR.

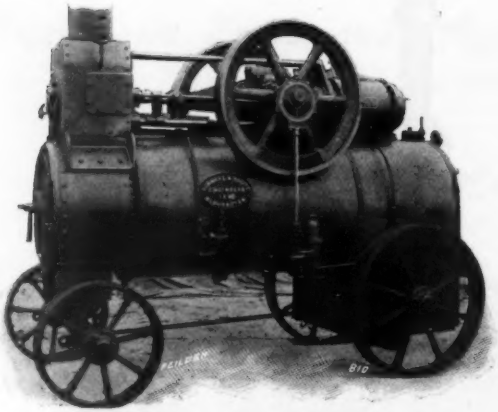


FIG. 17.—"SCOTT" PORTABLE AIR-COMPRESSOR.

valve-case caps, *B* is a discharge valve, *C* a removable seat for same, *D* an intake valve, *E* lever actuated by governor piston *F*, *G* the governor cylinder, *H* the governor valve, *I* a diaphragm over *H*, *J* a small spring to keep *H* against *I*, *K* a plunger resting on *I*, and regulated by a tension spring *M*, *N* accidental leakage port, *O* connection leading to air receiver, *P* another leakage port from above piston *F*, *U* a spring to hold lever *E* up to piston *F*, and away from intake valves *D* *V* discharge chamber in valve case connecting with discharge pipe of compressor, *W* water jacket to valve case, *X* intake box from outer air. The action is as follows:

When the force of the compressed air under *I* is greater than the stress of spring *M*, the valve *H* leaves its seat, and the piston *F* is forced downwards. This raises the intake valve *D* and keeps it from its seat, so that the compressor works directly to the open air, consuming no power beyond what is required to overcome the friction of its moving parts. The compressor was illustrated in the last article, and the position occupied by the valve casing will be readily seen by reference to the block. With the exception of one, all the compressors so far dealt with have been of foreign construction, and it is now proposed to consider a few British-built types.

In connection with pneumatic tools, which are for the most part portable, the advantages of a portable compressor are undoubtedly considerable, especially when work has to be done in the open, or at some distance from the source of air supply. The "Scott" type of a portable compressor, which is here shown (Fig. 17), should fulfil a want in this direction. It resembles in appearance an ordinary portable steam engine, and in fact can be used as such by disconnecting the air cylinder. This cylinder is shown on the top of boiler to the right of the flywheel, and its piston is driven direct from the piston rod of the steam cylinder. The piston rod is formed with a slot in the middle to clear the crank, the latter being connected to the crosshead in the ordinary way by means of a connecting rod.

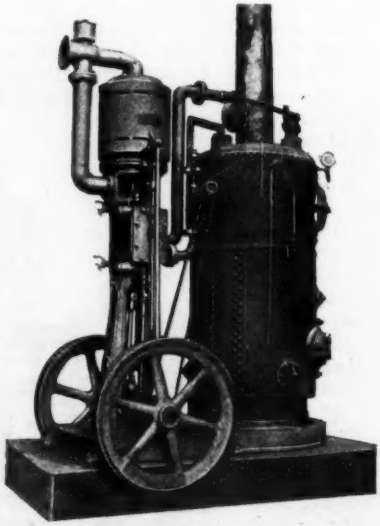


FIG. 18.—"SCOTT" VERTICAL AIR-COMPRESSOR, WITH MECHANICALLY WORKED INLET-VALVES OF LARGE AREA.

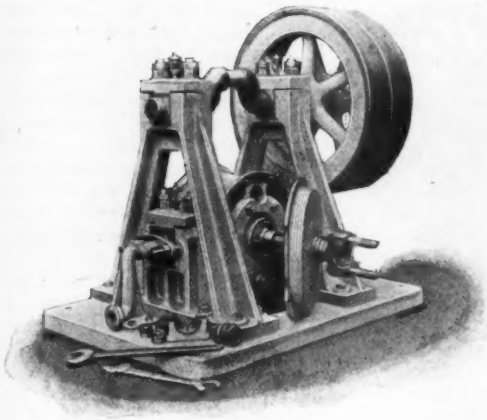


FIG. 19.—"HOWARD" OSCILLATING CYLINDER COMPRESSOR, PARTIALLY DISMANTLED TO SHOW VALVE.

tion of cylinder and valve box is seen in the illustration. By this arrangement a small travel of the valve gives a very large air admission, as it is practically a circular grid valve, and has at the same time a positive action, thus ensuring that the cylinder takes in a full charge of air at every stroke, permitting also, as has been pointed out, a high speed to the compressor. By attaching a pipe to the valve chamber air can be drawn from a distance. This is frequently necessary, especially if the compressor is being used underground, or in a heading for driving percussive or rotary rock drills. The engine is so

The air cylinder is fitted with a special arrangement of mechanically worked inlet valves which, besides providing for a very large admission area (some 25 per cent. larger than is allowed in most compressors), enables the compressor to be run at a much higher speed than usual. This is a feature of considerable importance where weight and portability are concerned, as it enables a smaller sized compressor to be used. The arrangement of the air cylinder and valves may be briefly described. The cylinder, which is water jacketed both at the ends and sides, has inlet ports consisting of slots round the whole of its circumference at each end. The inlet valves consist of rings, fitting round this portion of the cylinder and receive a reciprocating motion from eccentrics on the crank shaft, whilst the rods which actuate the valves pass through two stuffing boxes in the front cylinder cover. The end por-

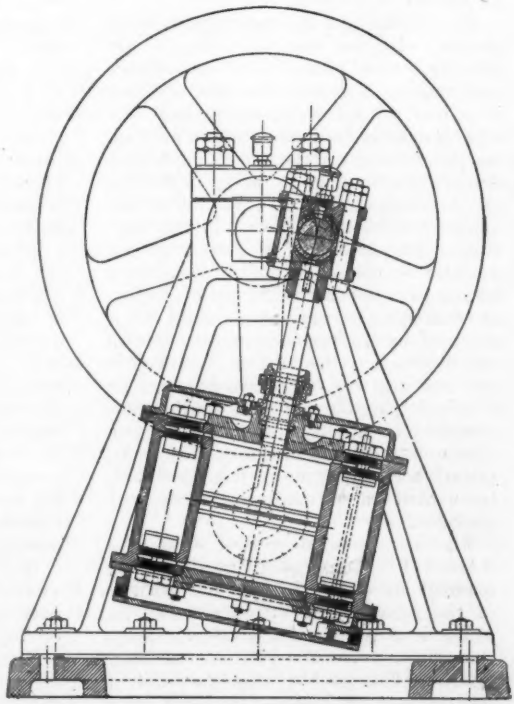


FIG. 20.—SECTIONAL VIEW OF "HOWARD" COMPRESSOR.

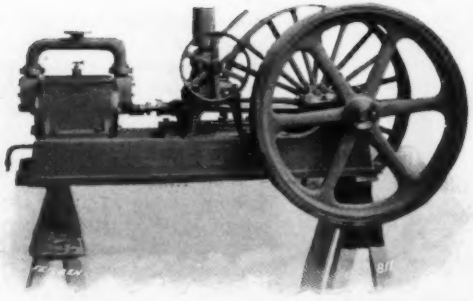


FIG. 21.—"TILGHMAN" HIGH-PRESSURE HORIZONTAL BELT-DRIVEN COMPRESSOR FITTED WITH AUTOMATIC BELT SHAFTS.

mounted on the boiler as to permit of the expansion of the latter. The whole forms a complete portable plant, as the engine pumps the cooling water supply to the air cylinder and uses it again when warmed for its own feed supply.

Fig. 18 illustrates the same type of compressor. In this case, however, the air cylinder is fitted to the top of an ordinary vertical steam engine, the piston rod of which is carried through its cylinder cover. In this illustration the valve is shown working on the outside of the air cylinder and entirely surrounding it, being driven by two eccentrics and rods worked from the crank shaft of the engine. In the belt-driven compressors of this type the air cylinder is placed direct on a cast-iron frame, as in the case of a vertical engine, or when lightness is a consideration this is replaced by four steel columns. One of the flywheels is then driven by a belt in the ordinary way. The above types are wholly or partially portable, but the same principle is adopted for large and permanent installations, the air cylinder being placed horizontally and driven preferably by Corliss valve steam cylinders compounded.

Fig. 19 shows an outside view of a "Howard" compressor, partially dismantled in order to show the position of the valve in the cylinder. Fig. 20, which is a sectional view taken through the valves, shows the position still more clearly. The machine consists mainly of two cast-iron *A* frames, carrying a crank shaft and fast and loose pulleys, the fast one being also a flywheel. This crank shaft drives the oscillating cylinder in the ordinary way by means of a connecting rod. The trunnions on which the cylinders turn are hollow, and form the entrance and exit passages for the air to and from the cylinder. The delivery pipe is clearly shown in Fig. 19, being fitted with a gland to permit of the pipe connection to the trunnion being stationary. The cylinder is water jacketed all round, also top and bottom, and suitable ports are formed in the body of the cylinder leading from and to the trunnions. As seen by reference to Fig. 20, there are two straight-lift suction valves at the bottom of the cylinder, and two similar delivery valves at the top, each pair of valves being in direct communication with the hollow trunnion. It will thus be readily seen that on rotation of the crank, the action of the piston will tend to actuate these valves as in any ordinary double-acting suction and delivery pump. There is also provided with this compressor, but not shown in the illustrations, an automatic belt-shifting device, in which a piston-working in a cylinder (which has direct pipe connection with the air receiver) is caused to control the valve of another cylinder, whose piston is directly connected with the belt shifting rod. As soon as the air in the receiver rises above a certain pressure, it opens the valve mentioned, and causes the belt shifter to travel and thus shift the belt on to the loose pulley. As soon as the pressure reaches the normal, the regulating mechanism acts again in the opposite direction to return the belt to the fast pulley.

A device on much the same principle was described in the last article, in connection with the "Pedrick and Ayer" type of compressor

Some of the leading dimensions of this compressor are:—Size of cylinder, 8¼ in. diameter, by 7½ in. stroke; air discharge,

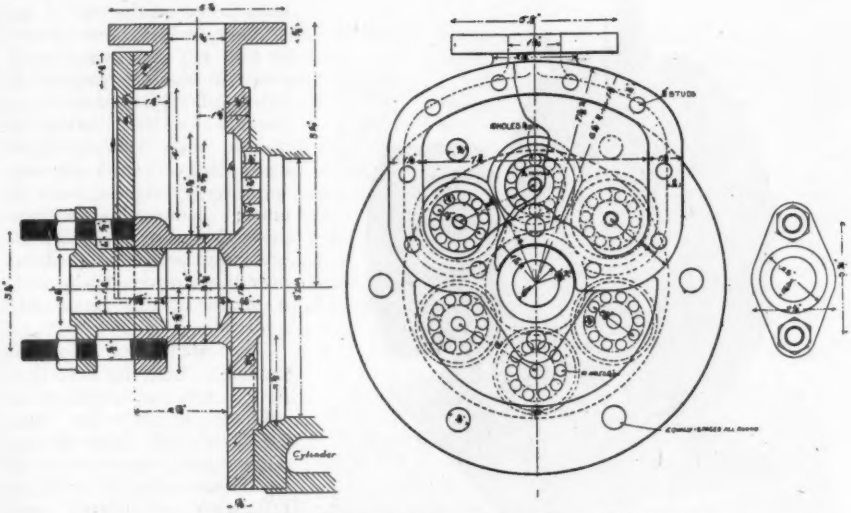


FIG. 22.—SECTIONAL VIEW THROUGH VALVE CASING OF TILGHMAN'S COMPRESSOR.

$1\frac{1}{4}$ in. diameter; capacity, 60 cubic ft. of free air per minute when driven at 120 revolutions per minute. This output may be readily increased by coupling up two compressors by their shafts, and placing the pulleys in the centre, the cranks being set with angular advance of 90 degrees, and the delivery pipes run into a common pipe.

Fig. 21 illustrates the "Tilghman" type of belt-driven horizontal compressor suitable for pressure up to 100 lbs.[1] per sq. in., whilst Fig. 22 shows a section taken through the valve casing. This type of compressor is built in a variety of designs, both vertical and horizontal, belt and steam driven, side by side and tandem, but a description of the design shown by the illustrations will indicate the principal points embodied in this type. The distinctive features are the valves and the automatic striking and belt-shifting gear. With regard to the latter, want of space unfortunately prevents the illustration of it in detail, but it is seen in Fig 21, in the centre of the block, a small pulley just to the left of the fly-wheel forming a part of its mechanism. It consists mainly of three parts which may conveniently be termed *A*, *B* and *C*, *A* being an operating mechanism, *B* a regulating mechanism, and *C* the belt-shifter gear proper. *A* comprises a pulley driven from overhead, and always running when the compressor is at work. The rotation of this pulley and its shaft imparts by suitable mechanism a horizontal reciprocating motion to a tappet, sliding in guides, and forming part of the mechanism of *B*. *B* is a weighted plunger, working in a vertical cylinder and in direct pipe communication with the air receiver. This plunger is connected to the tappet referred to, and causes it to rise and fall according to the pressure in the cylinder, but does not affect its horizontal reciprocation. *C* is the usual belt shafting device, but so arranged that if the reciprocating tappet hits it when the latter is up, it moves it in one direction, and when down in the other. If this description has been followed, the action will at once be seen. *A* is continuously imparting a reciprocating motion to the tappet forming part of *B*. Another part of *B* is a piston actuated by the air pressure in the receiver, and this piston carries the tappet up and down as the former rises and falls. In its turn the tappet strikes *C* and shifts

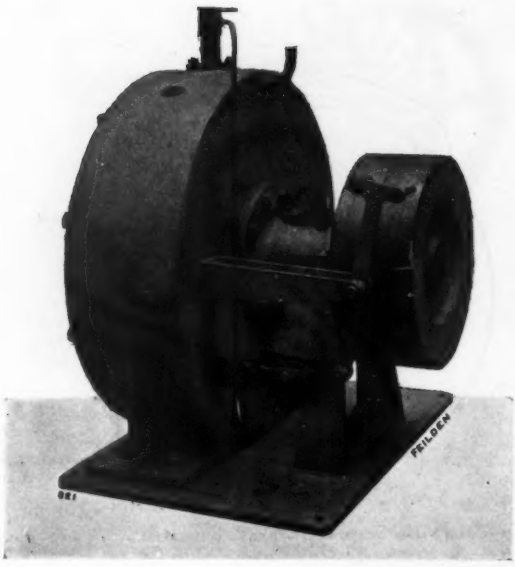


FIG. 23.—"BROTHERHOOD" THREE-CYLINDER COMPRESSOR.

the belt in one direction or another according to whether the piston of *B* has forced the tappet up or down. In the larger compressor an automatic relief valve is adopted in place of the belt-shifting device; this provides that when the working pressure is exceeded, a valve is opened and the air in the cylinder allowed to escape without being compressed.

With regard to the general design of this compressor, reference to Fig. 21 will show that it is somewhat similar to that of an ordinary horizontal steam engine, the chief difference, however, being in the cylinder and valve arrangement. This is seen more clearly in Fig. 22, which shows a section through the valve chamber, and an end view of cylinder with part of valve-box cover removed. The valves are of very simple construction, and differ considerably from the ordinary type. They consist of a plain thin metal disc, about $\frac{1}{16}$ in. thick, and held in position by a central bolt; a spring of special construction permits the disc to lift from the valve port (which consists of a ring of holes bored on the end of the cylinder, and seen more clearly in Fig. 22), but immediately closes it when the pressure is released. The advantage claimed for these valves is due to their extreme lightness, since a 3-in. valve and spring only weighs about one ounce; hammering is thus avoided and the liability to breakage prevented. Moreover, they are very cheap and, if necessary, can be readily replaced.

The same type of compressor is built in a vertical form, with a single-acting cylinder suitable for high pressures and belt driven. This is a very handy type for small sizes, as it occupies little space and is easily fixed. The valves are of the same kind as just described, and in order to give some idea of size and capacity, it may be stated that a machine having cylinder 4 in. diameter and 6-in. stroke, will deliver 10 cubic feet of free air per minute, at a pressure of 80 lbs. per square inch, when driven at 250 revolutions per minute, and absorbing 1·8 i.h.p. The diameter of the delivery is $1\frac{1}{4}$, and the machine weighs 4 cwt.

Fig. 23 illustrates an outside view of a "Brotherhood" type of compressor, capable of being driven by either belt, steam, or electric power. In the case of steam driving the cylinder is attached direct to the machine. As will be noted, the machine illustrated is for belt driving, and the arrangement of the working parts is on the lines of the "Brotherhood" steam motor. It consists of three cylinders placed inside a casing or tank at angles of 120 degrees; the tank also forms a water jacket for cooling the cylinders. It is a one-stage compressor, although there are three cylinders, since each cylinder compresses in turn its own charge up to the full pressure and delivers it into a pipe common to the three cylinders. The air first enters the crank chamber, from

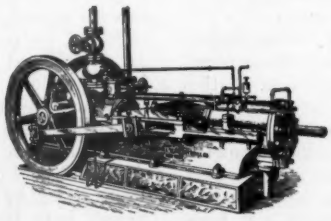
which it passes into each cylinder in turn through a port in the cross-head pin, and after being compressed is delivered through a valve in the end of each cylinder. The belt-shafting device is connected by pipe to the delivery pipe, and provides for throwing the belt on to the loose pulley as soon as the pressure exceeds the normal amount.

It has not been attempted in the two articles which have been devoted to this portion of the subject to deal with all the compressors on the market, and several types have not received any reference, the main idea being to describe a few of the most representative which are specially adapted for the purpose of driving pneumatic tools and appliances; one more type, however, will be referred to in the next article before resuming a consideration of the tools themselves, as it embodies some valuable features, both in principle and in details of construction. Amongst the features that a good compressor should possess are (1) Efficiency. (2) Simplicity in design. (3) Carefully constructed parts, only the best material and workmanship being employed. (4) Facility for inspection, and capable of being readily repaired. (5) A simple and efficient mechanism for maintaining a constant pressure in the receiver. As to the power required to drive, in relation to the number of cubic feet of free air compressed per minute, this of course varies according to the pressure maintained, and also in regard to the size of the compressor, the larger ones being rather more economical. For pressure over 80 or 90 lbs., a two-stage compressor is generally to be recommended. As a guide, however, to the power required to compress a certain quantity of free air, it may be stated that a belt-driven compressor delivering 50ft. of free air per minute at a pressure of 80 lbs. per sq. inch would require 8 brake h.-p. to drive it, or, say, roughly 5 to 6 cubic ft. of free air per brake h.-p. for pressure up to 80 to 100 lbs. per square inch.

The possession of a good reliable compressor is a very important feature in any pneumatic tool installation, and too much care cannot be taken to insure having this.

(To be continued.)

Ewart S. Amos



F 2

The Building of a Great Railway.

The Great Central Extension to London.

(Continued from page 60.)

❀ ❀ ❀

DURING the excavating operations a large quantity of water was encountered, and pipes, called feeders, were laid at certain points with open joints, along the clay bed. These catch the water which percolates through the gravel bed, and convey it to a reservoir provided for the purpose, about half a mile to the south of Rugby, in the Barby Road. Here there is a tower built, supporting a tank; and after passing through a filter bed, the water is pumped up to the tank, whence it gravitates towards the tower.

The principal water supply at present, however, is obtained from the River Avon, at the north side of the town. The Great Central Railway Company had, however, to pay a compensation, by their Act, of £7,000 to the Rugby U. D. C. for interfering with this water-bearing area by carrying the Rugby cutting through it.

Two of the feeders above mentioned were met with during the excavation, and these were connected up by means of inverted syphons carried across the cutting.

The Rugby cutting is 48 ft. at its greatest depth, with slopes 3 to 1 where 20 ft. deep and upwards, and 2 to 1 where under 20 ft. deep.

To guard against injury to the slopes by water from the gravel, an intercepting drain was formed on each side of the cutting. This drain was cut about 4 ft. from the boundary fence, and carried down to the clay bed. Nine-inch diameter pipes were then laid, open jointed, with half their diameter in the clay bed, and covered with rubble for about 2 ft. high above the top of the pipes. The trenches were then filled in with the excavated material. At certain points, dependent upon the lie of the clay bed, the pipes were brought through the slope, and led into the ordinary side cutting drain. At every 10 chains there is an inspection chamber with manhole cover.

In addition to the bridges which span this cutting, several sewer culverts and syphons had to be provided, one of 3 ft. 6 in. diameter, brick; two of 18-in. cast iron pipes; and one of 9 in.

All pipes that were passed under lines of any kind were, to prevent crushing, either of iron or earthenware thickly cased in cement concrete.

Approaching the point at which the cutting is 17 ft. in depth, a bridge carrying the Hilmorton Road is reached, which communicates directly with the town of Rugby. The bridge has been used as an approach to the Rugby Central Station, the island platform below being reached by a stairway, a hand lift having been provided for luggage. A roadway, with a descending gradient of 1 in 30, has been provided for goods, and another fenced roadway communicates with the cattle docks and carriage landing. The platform is 500 ft. long, of the usual island type, tapered at each end, reaching a maximum width of 35 ft. 6 in. on the surface, and 32 ft. wide at rail level. Roofing has been provided for a length of 157 ft. Parachute water columns at each end of the platform, a 10-ton crane, and small warehouse have been provided.

To allow for the shunting of slow traffic, "lay by" sidings, each 500 ft. in length, have been laid down in addition to the usual "up" and "down" sidings.

Proceeding southwards, the Hilmorton-Dunchurch Road is carried over the cutting, where it is about 47 ft. deep, by a skew arch bridge consisting of three spans 55 ft. 6 in. each.

Immediately to the south of this cutting the line is carried on a bank 1 m. 26 chs. long, containing 519,000 cubic yards. It reaches a maximum depth of 48 ft., while the slopes are 3 to 1. This bank crosses one public road, one bridle road, and two farmers' roads. A culvert for the Rainsbrook, which gave considerable trouble owing to the slippery state of the clay, also penetrates this embankment.

The spoil from the Rugby cutting was deposited on land, 7 acres in extent, to the east of this embankment.

About 2¾ miles south of Rugby the line runs close to, and nearly parallel with, the Oxford Canal, and convenient access for wharves has been established at several points. Here the contractors formed their chief depôt, and procured most of their material by barge. A temporary connection was, however, made with the L. & N. W. Ry. Co.'s Daventry and Leamington branch, by which means the contractors brought a large quantity of material of all kinds on to the works.

From this point for the next two miles the earthwork is comparatively light.

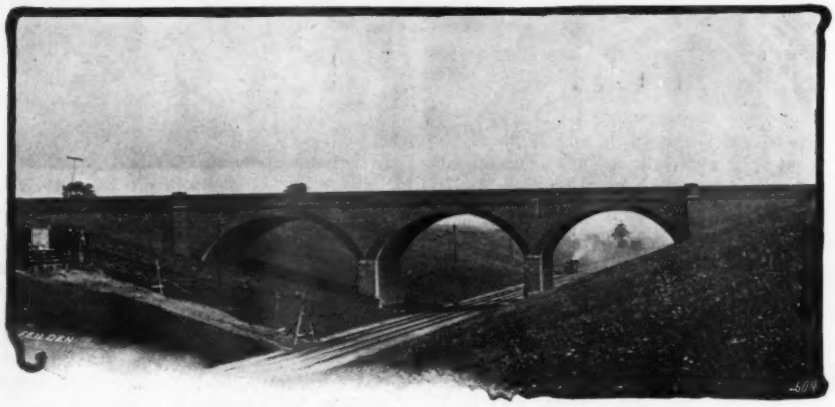
Willoughby Station, of the usual country type, in bank about 17 ft. high, occurs in this portion of the line, and is 4½ miles south of Rugby Station. It is approached from the main Daventry-Dunchurch Road, which passes under the railway on a very bad skew.

About 54 chains south of Willoughby the line crosses the River Leam Valley, partly on embankments and partly on the Willoughby Viaduct, which is 186 yds. long, back to back of abutments, and has 13 arches of 34 ft. 3 in. span, with a height of 40 ft. from ground trails.

The weight per square foot on clay under the foundations is 2·50 tons, including rolling load. The piers are built parallel both ways, and not tapered, as in the Catesby and Staverton Viaducts.

The bank in which this viaduct occurs contains 342,000 cubic yards, and is 1½ miles long. It is intersected by six bridges one of which is a public road bridge, the remainder being farmers' occupation bridges.

At 26 chains south of Willoughby Viaduct the Oxford Canal is again crossed by a girder bridge of 53 ft. 2 in. skew span; and 31 chains farther south, the Leamington and Daventry branch of the L. & N. W. Railway is crossed by a span of 58 ft. 2 in.



"HILMORTON-DUNCHURCH" ROAD BRIDGE ACROSS DEEPEST PORTION OF RUGBY CUTTING, LOOKING SOUTH.

ENLARGED PORTION OF "WILLOUGHBY VIADUCT," LOOKING EAST, WITH VIEW OF BRAUNSTON CHURCH THROUGH ONE OF THE ARCHES.

After another small cutting and a bank containing 88,400 cubic yards, the line passes through another large cutting of about one mile in length, out of which 241,000 cubic yards were excavated. This was the first cutting of any size finished on this sub-division, and it is spanned by three over-bridges.

At Shuckburgh, it was intended to place a station of the country type, but in deference to the wishes of an influential landowner, the matter has been postponed for the present.

The small cuttings in the parish of Willoughby, and approaching Willoughby Wharf, between 56 miles 20 chains and 57 miles 10 chains, are in clay of the most irregular constitution, grey, green, and red, and containing small nodules of most fantastic shapes. Judging by the few fossils found, and more by those absent, the beds must constitute a kind of transition zone from the Armatus to the Jamesoni zones. There is a little drift gravel on these cuttings.

Passing Willoughby Station, and crossing the viaduct over the River Leam, and just after crossing the Oxford Canal, the small cutting at 58 miles 55 chains, which extends for about 12 chains, is in the Jamesoni zone, and consists of a brownish clay with ferruginous nodules and much selenite, but few fossils.

The much deeper cutting in the Parish of Wolfhamcote, which occurs soon after crossing the Daventry and Leamington Railway, is a stiff blue clay throughout, the lower part (6 to 12 ft. shown) is in the Ibex zone, the greater part in the Henleyi zone, and possibly a little Capricornus zone at the top.

A contiguous, but not very deep, cutting is, no doubt, all Henleyi zone, excepting a little boulder clay on the top, but at 59 miles 9 chains a "fault" occurs, and the remainder of the section south of this is most interesting, showing a light-blue clay abounding in *Rhynchonellæ*, and containing numerous light-coloured nodules in which these fossils were almost equally abundant. The most characteristic ammonite was *A. pettos*, from the presence of

which, and from other circumstances, we may fairly conclude that this represents a special local development of about the middle portion of what would mostly be called the Jamesoni zone.

Southwards, to the neighbourhood of Finmere, the country becomes very undulating, necessitating heavy embankments and cuttings, with one tunnel. The first valley is spanned by Staverton Viaduct, situated in a deep ravine 58 ft. deep where the River Leam intersects it.

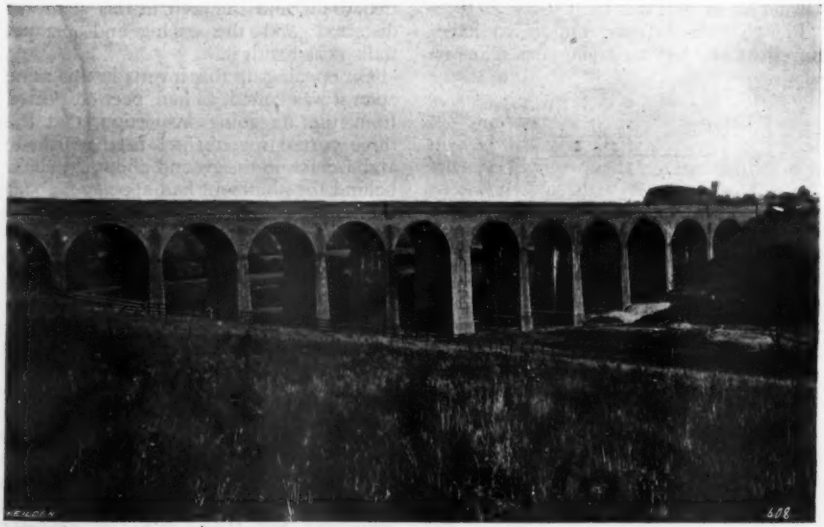
The Staverton Viaduct is nearly similar in design to that of Catesby, and is 357 ft. long between abutments, and has 9 arches of 34 ft. 3 in. span. The foundations are in strong blue lias clay. The weight per square foot on the blue clay varied between 2 tons and 2¾ tons, including the rolling load. In plan the viaduct is straight, and is built on a gradient of 1 in 176, rising south.

It was decided to place inverts between the piers for its entire length. Partial inverts were therefore built, viz.: three of 5 ft. wide in each of the three spans at the north and south ends, whilst the three centre spans had complete inverts; that is, their width was made the same as the viaduct.

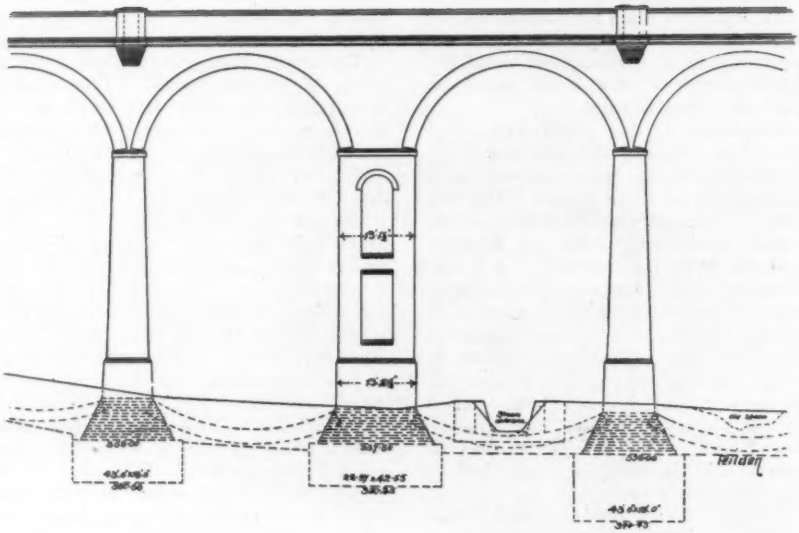
The height from ground to rail level is 60 ft. at the maximum. The viaduct runs practically north and south across the steep ravine, intersected by a stream which feeds the River Leam on the east.

In July, 1897, when the viaduct was finished, the bank at the north end was pushed forward to join up and finish around the abutment. About the latter end of that month it was noticed that the coping showed an uneven line on the top. On taking levels, it was found that the coping had risen over the second arch from north end; whilst at the abutment it had sunk about 6 inches. A careful watch was kept, and as the movement increased fresh levels were taken, and careful measurements and plumbings, with the following results:

The north abutment had moved southwards about 4 in. at springing height and still more at the toe, the face showing a batter of about 1 in 66 instead of being plumb. The level at springing also was 7½ in. lower than built. On examining the first pier an almost parallel movement



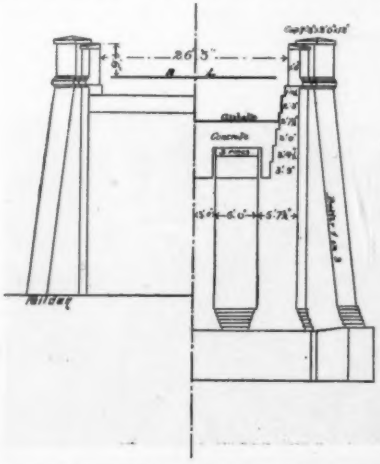
CATESBY VIADUCT, LOOKING SOUTH-EAST.



CATESBY VIADUCT: DETAILS OF PIERS, NOS. 5, 6 AND 7, ARCHES AND INVERTS.

with the abutment was found to have occurred southwards, but it had only gone down 1 in. since it was built.

Pier No. 2 did not appear to have moved at all, but on trying the span at



CATESBY VIADUCT: HALF SECTION THROUGH PIERS.

springing height, between it and pier No. 1, it was found to be 4 in. shorter than built, and the arch in this span was distorted and the coping and parapet walls raised with it.

On opening up the inverts in this same span it was found, as had been expected from the foregoing inspection, that the three partial inverts had been crushed; and a crack in the ground about a $\frac{1}{2}$ chain behind the abutment had appeared, about 4 in. widee, xtending well into the field beyond the railway fence on the west and as far as the fence on the east side, and taking a direction diagonally across the railway from N.W. to S.E. It appeared, therefore, that a large portion of this side of the ravine had taken a south-westerly movement towards the valley, which was actually the case; the movement in the ground, which also extended through the newly-tipped bank, corresponding with the measurements taken previously at the viaduct.

The first thing done was to substantially strut the first three arches temporarily with timber, viz., those partially inverted;

then to build in brindle brick in cement, struts 5 ft. thick between the crushed inverts; then to restore the partial inverts which had been crushed, similar struts having been put in between the partial inverts of the third arch meanwhile. The first span, viz., that between the abutment and first pier, was next dealt with as follows:

Between the three partial inverts of this span the ground was excavated down until the slip was reached, the approximate depth of this having been ascertained previously by sinking a trial hole on the east side of the viaduct. The line of slip, distinctly marked, was met with at an average depth of 16½ ft. below the surface, and was dipping from east to west about 1 ft. in 3½; and also dipping south 1 in 3. That is, there was a sliding surface from N.E. to S.W. corresponding with the first crack in the surface of the ground, before mentioned, sliding at right angles to it.

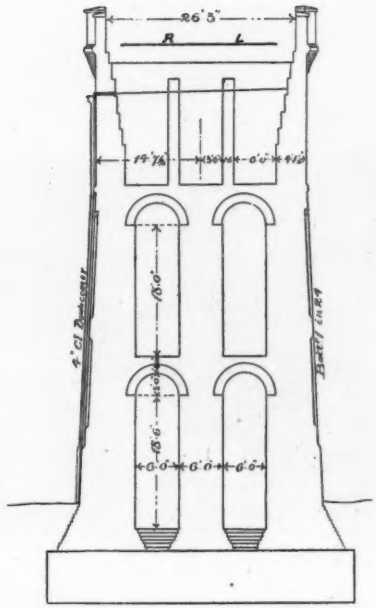
The excavation was carried down some two or three feet below the lowest line of the slip, and parallel with the bed line of it, and the trench filled in with cement concrete 7 to 1; the top of these struts being brought up to the invert level.

These two solid struts therefore form a dowel also between the sliding surfaces of the slip.

Further precautions to guard against any further movement of the ground were adopted as follows: At the same (north) end of the viaduct, on either side of pier No. 1, solid concrete walls about 30 ft. long and 10 ft. thick were carried down well below the bed of the slip forming strong dowels, the wall in its length being parallel with the movement of the slip, the ends of these walls nearest the viaduct being some 20 ft. away from it.

These two dowel or stop walls were brought up above ground line about 3 ft. 6 in. and form a stop for the toe of the bank which covers them. The arch, which had become distorted, was afterward recentred and restored to its proper shape. The parapet also was taken down and rebuilt, as was also some of the spandril work which had been disturbed.

No further movement has since occurred.



CATESBY VIADUCT: SECTION THROUGH PIER NO. 6

The remainder of the embankment contains over 170,000 cubic yards of earthwork.

A quarter of a mile south of this point the line crosses another very similar ravine, which is 61 feet deep, near the River Leam, which is crossed for the second time by the Catesby Viaduct.

This viaduct, 476 feet long between abutments, consists of 12 arches of 34 ft. 3 in. span at the springing, with a rise of 14 ft. 6 in. The piers are 5 ft. 3 in. wide at the springing height; and in side elevation they taper 1 in 30, gradually widening towards their base. In transverse view, they taper 1 in 24. Here is one stop pier, 13 ft. 1½ in. wide.

The foundations are in strong blue lias clay, and vary from 10 ft. to 20 ft. deep below ground. The concrete in foundation is of cement, 7 to 1, and varies in thickness from 4 ft. 6 in. to 11 ft. 6 in.; the length varying from 37 ft. to 43 ft.; and the width 12 ft. 6 in. to 19 ft.

CATESBY TUNNEL: SOUTH FRONT.

The weight per square foot on the blue clay with rolling load is 2½ tons nearly.

The drainage of the surface water is effected by sloping the spandrel tilting towards one side of the viaduct, and taking a drain pipe through the spandrel wall to the hopper head of a down pipe at each pier. After the arches were turned, the outer spandrel walls were then carried up as usual, and in order to divide up the concrete filling to the haunches, two extra spandrel walls, each 18 in. thick in cement brickwork, were introduced, thus dividing the width into three separate pockets.

In order to guard against the effects of the concrete swelling after having been deposited in the pockets, and pushing the outer spandrel wall over the faces of the arches at the "collar" joint, which effect had been noticed at one of the viaducts previously built; some thin planking was introduced, or rather placed against one of the faces of each of the two inner spandrel walls, and after the concrete had set, these planks were drawn away, leaving two small spaces for the concrete to fill up if any swellage took place.

After the concrete had set the whole of the top surface of the viaduct from end to end was coated with Cliffe's asphalte, laid in five layers, viz., three of asphalte and two of brattice cloth, one of each alternately; and, as before mentioned, the drainage was taken through one side of the viaduct, and led down by pipes, in preference to building in a pipe through each arch and allowing the water to drip down on the ground below in each span.

Inverts were built between all the piers in the first instance. Three of the inverts, viz., those on each side of the stream, and that under the stream were whole inverts. The others were partial inverts, viz., three of 5 ft. wide on each span.

In order to guard against the possibility of the bank at the south end slipping towards the stream at the bottom of the ravine, and damaging the viaduct by so doing, extra strengthening precautions were taken by inserting concrete struts between the partial inverts at that end of

the viaduct. The arches were turned in the usual way, the contractors using four sets of centering, and bringing forward the back centering as soon as advisable after that arch had been keyed in, proceeding in this manner from one end of the viaduct to the other.

The greatest height from ground to rails is 63 ft.

The viaduct is straight in plan, and built on a gradient of 1 in 176, rising towards the south, and crosses a steep ravine, through which runs the river Leam from east to west.

The next bank contains 350,400 cubic yards and is between 50 and 60 chains long, and has slopes of 3 to 1, as the clay which came from the adjacent tunnel proved very treacherous.

The north end of the Catesby tunnel is next reached at 10 miles 66 chains from the commencement of the southern division.

This tunnel is nearly 3,000 yards in length, 27 ft. wide, and 25 ft. 6 in. high. Staffordshire brindles have been used to face the whole of the brickwork, laid in cement wherever water was encountered.

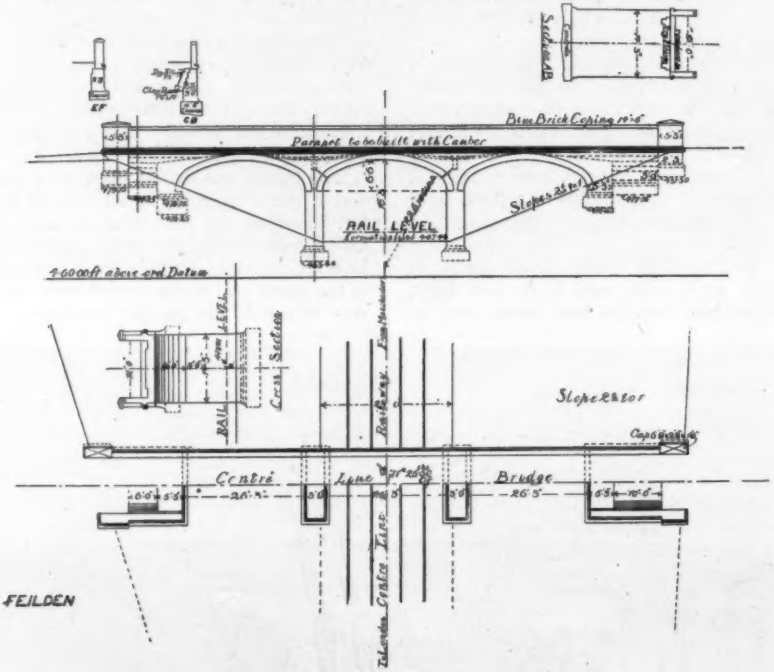
The tunnel cuts through the blue clay of the Capricornus zone for one-third of its length, and for the remainder through the sandy micaceous marls and clays and limestones of the Lower Margaritatus zone of the Middle Lias. At the northern end of the hill, over the tunnel, occur the sands, clays and limestones of the Upper Margaritatus zone, with the well-known rock-bed at the top.

The tunnel was constructed according to the ordinary English system, and in the Lower Lias the ground was found to be very heavy, but on the extension of the work into the Middle Lias no difficulty was experienced.

The tunnel was driven from nine shafts and a small opening in shallow ground, but the work was hampered to a certain extent owing to the action of a landowner in not permitting shafts within 500 yards of the north end of the tunnel, near which was situated his private residence. It

BRIDLE-PATH BRIDGE AT WOODFORD.

therefore became necessary to construct a length of 12 chains, in the very worst part of the ground, by putting in a bottom heading and breaking up. A distance of 44 yards at the north end was carried out in cut and cover, and, again, owing to landed interests, the tunnel had to be driven to meet the cut and cover. For the last length or two, however, there was very little cover, necessitating in the very last length the two crown bars being being spaced as close as possible constant breakages occurred, and in one portion a complete collapse took place which disturbed the superincumbent material and greatly increased the pressure. This necessitated the permanent lining of the tunnel being increased to 7 rings in arch and side walls and 6 rings in the invert. The bricks were laid in cement and faced with brindles, and the construction was proceeded with in short lengths of 10 ft.



DETAILS OF A TYPE ACCOMMODATION BRIDGE, SOUTHERN SECTION.

laid in from the surface, in a shallow trench, which was excavated to receive them, the remaining timbering being put in in the usual manner.

In keeping the heading open difficulties were encountered, sufficient space to permit the passing and repassing of wagons being only maintained by constant repolling back and retimbering. In spite of the side and head trees of the heading The slope of the disturbance did not exceed 1¼ to 1, which was shewn by cracks running to 2 ft. in a well-built and previously sound garden wall. The crown bars, which consisted of 14 in. square pitch pine, in some instances came down as much as 24 in., and here and there were broken through. To secure rapid progress in this section the work was started from five break ups, which proved

TYPE OF BRIDLE-PATH AND ACCOMMODATION BRIDGE NORTH OF WOODFORD.

TYPE OF PUBLIC ROAD BRIDGE SOUTH OF WOODFORD.

INTERIOR OF WOODFORD ENGINE SHEDS.

to be expensive work, which would have been minimised had it been possible to drive full sized as was done in the remaining length of the tunnel. This, with two insignificant exceptions, was all of a light description, the permanent lining consisting of five-ring work in the arch and side walls and four-ring work in the invert, the whole being faced with brindles built in lime mortar with an occasional length in cement to stop an incipient movement.

The work was materially assisted in places by the occurrence of beds of rock 3 ft. in thickness, which either had the effect of reducing the pressure or of affording a solid foundation for the timbering, according as it occurred above or in the work. The clay in this part of the tunnel was of a more solid character than that occurring at the north end, so much so that, with small face exposure, it stood for over a year without support.

A fairly constant flow of water, amounting to about 80 gallons a minute, occurred, the major portion of it emanating from the rock beds through which the shafts penetrated. As there was no apprehension of a washout behind the work taking place free drainage was decided upon, which was accomplished by chases built in the back of the brickwork, leading to pipes run through the side wall at rail level, from which the water flowed into a brick culvert situated in the six-foot way. This water is utilised for a garden and farmyard, a portion of it being raised by an hydraulic ram provided by Messrs. H. Blake & Co.

Four shafts of 10 ft. diameter and one of 15 ft. ventilate the tunnel, the increased diameter of the latter being due to the fact that it is situated $\frac{3}{4}$ mile from the north end of the tunnel, the shafts are covered with gratings made of expanded metal rolled into the shape of a hollow cone, thus preventing an accumulation of

stones which instead of collecting roll off. The tunnel is straight and on a rising gradient of 1 in 176 throughout towards the south. The greatest error was 1½ in. out of the centre, and in many cases not more than ⅛ to ¼ in. About 290,000 cubic yards of mining were executed and about 30 million bricks were used. The work, which established a record in tunnel building, was commenced on the 18th February, 1895, and the last length was keyed in on the 22nd May, 1897, an average rate of 110 yards per month dating from the starting of the first shaft. The best progress was at the rate of 1½ ft. per day.

The tunnel opens out into a cutting containing over 410,000 cubic yards of earthwork. A considerable slip occurred here, owing to the upper portion sliding bodily on a back or greasy bed. It was cured by burning out.

At a point where the cutting is very shallow Charwelton Station is situated, which is of the ordinary country type, and is approached by an over-bridge carrying the public road.

The section of the line following is of a light description, and just clear and south of a 12-ft. span over-bridge, built for the convenience of the late Lord Knightley, the Woodford sorting sidings commence, lying to the north of the public road between Charwelton and Woodford.

These sidings cover an area of 35 acres, a large area of adjacent land having been purchased on which permanent workmen's cottages have been erected. The bulk of this area is upon an embankment formed from spoil from the Catesby Tunnel. The design of these sidings is very similar to that of Annersley.

The railway crosses the Oxford Cherwell on a twin-span brick culvert of 7 ft. diameter each, and at the south end of the sorting sidings is placed Woodford and Hinton passenger station of the country type, and approached by an under-bridge from the public road. This station will become ultimately an important junction: the line to Nottingham and Manchester connecting to Towcester and Blisworth on the east, and to Byfield and Stratford-on-Avon on the west.

A loop line 35 chains in length branches off here to the East and West Junction Railway to Stratford-on-Avon.

Continuing, the line runs under the public road from Woodford to Byfield at a point where the cutting is 40 ft. deep, by a three-arch span skew-bridge.

This cutting proved very troublesome, owing to the nature of the clay and silt encountered, in some places the slopes having to be sodded immediately after trimming to prevent scouring by the rain. In one place the slopes had to be pitched for a considerable height above formation, and crow's foot drains led down the slope, while the bottoms of the cutting drains had to be paved with osiers, and the pipes themselves covered with straw to prevent their becoming choked.

Contract No. 4 terminates at this point. When the works were in full swing the number of men constantly employed was 2,000, while the plant consisted of 20 locomotives, 8 steam navvies, 550 wagons, and about 40 miles of rails.

(To be continued.)

MACHINERY APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

NEW EXPANSION SHAFT OR FLY-WHEEL GOVERNOR.

IT is by no means satisfactory to note how often it is necessary to avail ourselves of an American invention to complete machinery designed and built in England, but as an illustration of the fact that such is the case we may mention the "Pickering" Throttle-valve Governor, which in hundreds and thousands of cases forms the completion of a fine steam engine.

Bearing this particular case in mind, it is very gratifying to be able to illustrate and describe the Expansion Shaft or Fly-wheel Governor invented by Mr. Arthur S. F. Robinson, A.M.I.C.E., of Wantage, Berks, in which, like the "Pickering," it has the advantage of having no spiral springs, and allows of the speed of the engine being adjusted while in motion.

GOVERNOR FOR LOW-SPEED ENGINES WITH COVERS REMOVED.

The value of the principle of shaft governing has been admitted over and over again by the most competent authorities, but hitherto the complications of the governor itself, with its heavy weights controlled by spiral springs, which have a very uncertain life, plus the noise from back-lash of worn journals and the constantly varying friction of the internal parts, causing bad governing, have often necessitated the putting it out of action and have rendered throttle-valve governing (*i.e.*, governing by reducing the pressure of steam) much more popular than it ought ever to have been.

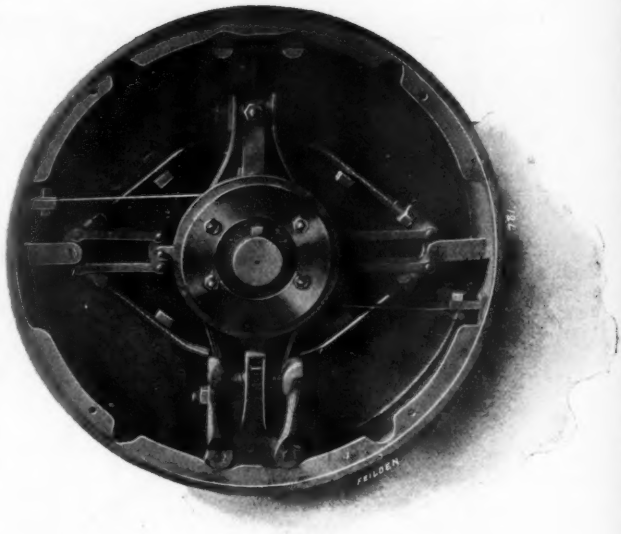
Mr. Robinson set to work with a view of eliminating the defects referred to, with the result that he has designed and patented at home and abroad, including the United States and Germany, a governor which bids fair to standardize the automatic expansion shaft or wheel governor in the same way as the "Pickering" has standardized the throttle-valve governor.

There are three important features in this invention now known as the "Robinson" Expansion Governor :—

1st.—The guiding of the frame which carries the eccentric in a straight line by a jointless form of Watts' parallel motion.

2nd.—The holding the eccentric frame in position by means of laminated steel blades, the arrangement so far being absolutely free from any working pin-joint at all. Mr. Wilson Hartnell, the pioneer of shaft governing in this country, has reported thereon as follows :—"The advantages secured are : The absence of working joints, the maintenance of accurate adjustment, besides being free from play and perfectly silent, without the necessity of very accurate fitting."

3rd.—The application of power to the springs by means of four lever arms instead of weights, arranged in such a manner that the centrifugal action of the one arm governs that of the other, rendering the forces at work in the governor extremely stable and capable of meeting much slide-valve resistance without being disturbed.



GOVERNOR FOR HIGH-SPEED ENGINES WITH COVER REMOVED.

Referring to the sectional drawings, Fig. 1 and Fig. 2, Fig. 1 is a longitudinal section and Fig. 2 a side elevation in section of a fly-wheel governor.

In Fig. 1, 1 is the eccentric, 2 the plate which carries the eccentric, 3 a corresponding plate on the other side of wheel.

2 and 3 are rigidly framed together by shouldered distance studs (4) which pass through slots in the wheel faces.

At the top and bottom of the distance studs (4) are fixed bridge pieces (5 and 6), to which, on either side, are fixed parallel motion steel blades or strips having their other ends bolted to projections from inside the fly-wheel rim.

The frame carrying the eccentric is in this way made to form the bar connecting the radius arms of Watts' parallel motion, and can be moved rectilineally up and down like the pencil of a Richardson's Indicator—a very important point, since the "lead" of the slide-valve is not altered as in so many other cases.

To effect this movement, laminated blades (9), passing between the parallel motion blades (7 and 8), are fixed to the adjustable supports (10) at one end, and to a crosshead and stud carried by a bridge piece (5) at the other or free end, so that when the bowed portion of the blades is pulled outwards the eccentric frame is moved downwards.

A A are lever arms hinged at B, and coupled and compensated in their action by the links (C) and compensators (D) which pull through links on spring backs arranged to roll and bear against the inside of the bowed blades.

The pin-joint connections being always in tension when at work, the governor is noiseless. This mechanical arrangement possesses great stability, since, owing to the extent of the lever arms, the centrifugal action is largely distributed around the wheel, and the compensating means, whereby one arm is bound to control the action of the other, renders it impossible to upset the forces at work.

A means of adjusting the speed by varying the spring pressure, when not required to be done whilst in motion, is shown in Fig. 2, where the castings (10) to which the springs are fixed can be adjusted by turning the set-screws (F) in or out against the fixed bar (G) within the wheel. The effect is to increase or decrease the curve of the springs at the part where the stiffening blades (H) are ranked.

The same result in the governor is obtained

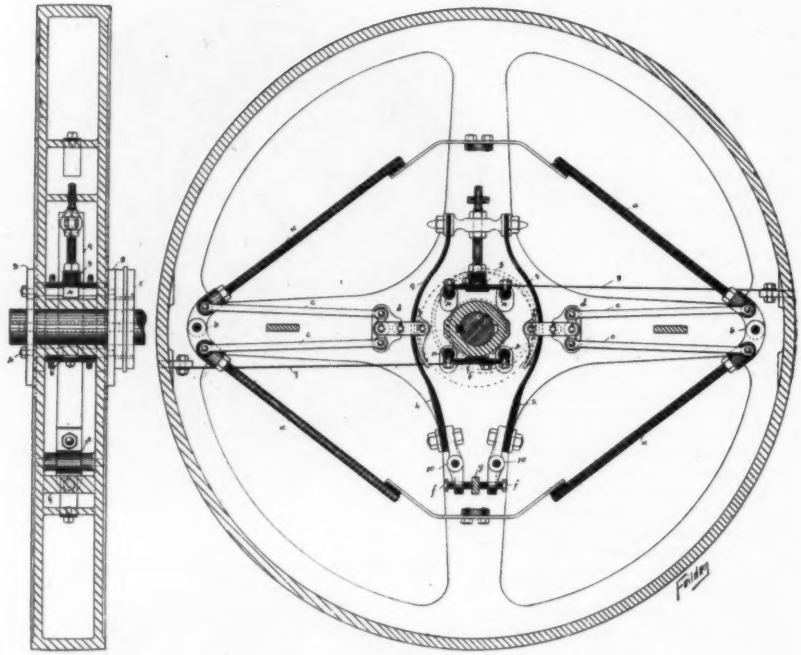


FIG. 1.—LONGITUDINAL SECTION. FIG. 2.—SIDE ELEVATION IN SECTION.

whilst in motion by sliding a disc on an extended portion of the crank-shaft, which by means of a rack turns the toothed wheel in one direction or another, and thus by actuating the right and left hand-screw, increases and decreases the spring pressure and the speed at which the engine will be governed. Mr. Wilson Hartnell, referring to this means of speeding, says :—"The means of adjusting the speed whilst the engine is in motion is often a great convenience, especially in electric lighting."

This governor, having now been brought to a point in which all hitherto existing objections disappear, ought to have a very bright future before it, as we trust will be the case.

The Editor of FEILDEN'S MAGAZINE

Will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

Heads of Departments

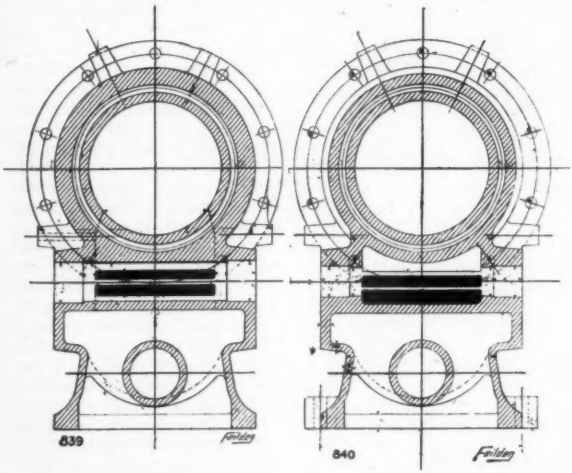
Foremen, Under-foremen, and Skilled Mechanics, are invited to communicate practical suggestions and drawings for insertion in the "Workshop Practice" section.

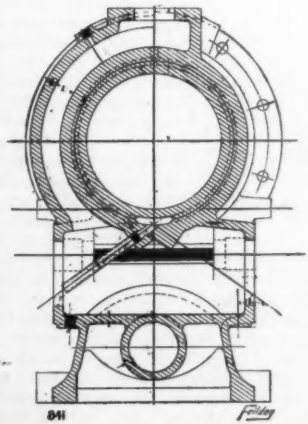
THOSE who are desirous of securing a copy of the magnificently bound Vol. I. of FEILDEN'S MAGAZINE should apply to the Publishers without delay. Only a limited number are now available. The patriotic and beautiful cover, a reduced facsimile of which appears elsewhere in this issue, will appeal to all Britishers.

TURNER-PEGG POSITIVE CORLISS GEAR.

THE name of "Corliss" is inseparably associated with one of the most important economies effected by steam-engine design. An invention, therefore, that claims to be an improvement on the Corliss gear is one entitled to serious examination.

In the Turner-Pegg patent, what is termed by the inventors their "Positive" gear has been substituted for the trip gear of the Corliss engine, over which they represent it to possess substantial advantages. Trip gears, as the patentees say, have serious disadvantages. Wrist bars break, pin brasses wear out quickly, and trip catches require constant renewal. A trip gear, as they point out, by the very suddenness with which it works, throws a heavy strain on all parts of the gear. Yet, these drawbacks admitted, the trip gear is still infinitely preferable on economical grounds, especially for high pressures, to the slide valve. In the first place, a body of power which increases with the size of the engine is consumed on moving the slide valves backwards and forwards. But when, in addition, the steam chest is filled with steam at a very high pressure, this power is very largely increased, owing to the increase of friction caused by the pressure at the backs of the valves.

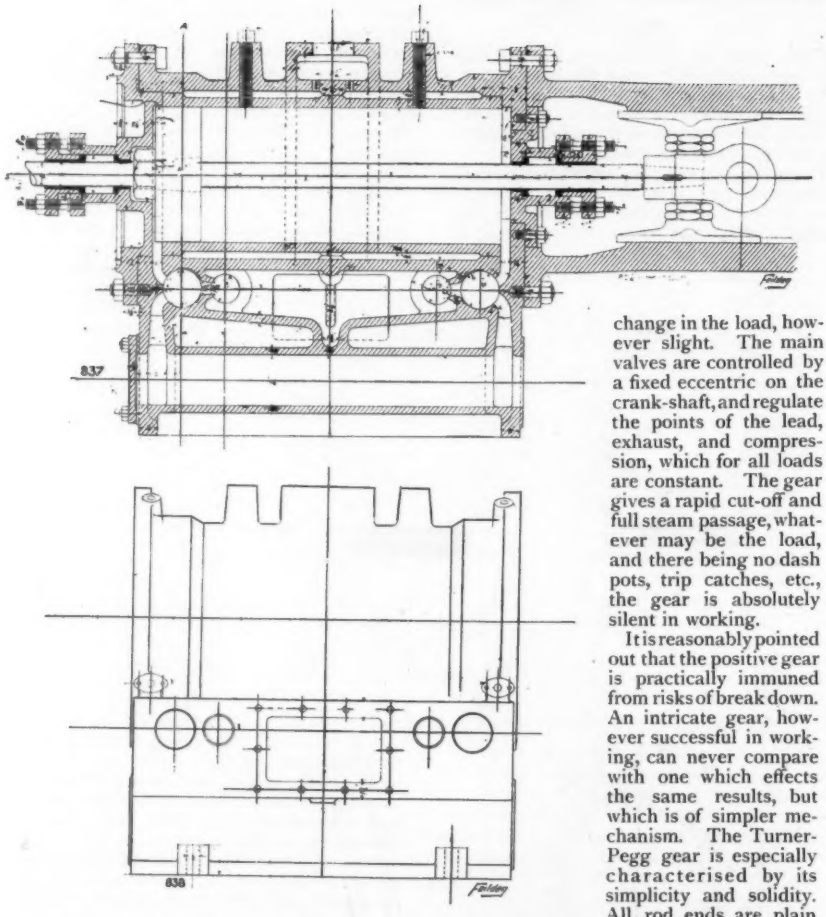




SECTIONS THROUGH A CYLINDER FOR 32-IN. STROKE COUPLED CORLISS ENGINE

Again, in the case of the Corliss gear, the steam passages are short and direct, so that the steam is admitted at once to the cylinder from the steam chest. There is only a minimum of loss in pressure between the boiler and the cylinder, conditions being equal, whereas in a slide-valve engine, a comparison between the boiler pressure and the initial pressure in the cylinder, as obtained by an indicator card, will show that the loss is considerable. Small clearance spaces, and a sharp cut off, also influence economy, and so far as these and other points are concerned, the trip gears unquestionably perform their work effectively, though associated with the disadvantages referred to.

We give some illustrations showing sections of the Turner-Pegg Positive Gear as applied to a Corliss steam engine. This gear consists primarily of a shaft governor acting by means of a rotatory cam or eccentric on the expansion valves. It is stated to be applicable to any speed or boiler pressure, with this qualification: that for speeds of above 90 revolutions a minute the eccentric is used; below that, the cam. The governor is of the shaft type. The weights, as will be seen, controlled by springs, are linked to the cam or the eccentric as the case may be, which is free to rotate round the



DETAILS OF CYLINDER FOR 32-IN. STROKE COUPLED CORLISS ENGINE.

crank-shaft; its position, relative to the crank, deciding the point of cut-off, this position being regulated by the governor weights. The stroke of the cam or eccentric is constant. The expansion valves with double cut-off edges are connected by means of rods and levers to the cam or eccentric, and control only the cut-off, which takes place always at the highest speed of the valve motion. Owing to their shape, they offer little resistance to the governor, which consequently adapts itself to any change in the load, however slight. The main valves are controlled by a fixed eccentric on the crank-shaft, and regulate the points of the lead, exhaust, and compression, which for all loads are constant. The gear gives a rapid cut-off and full steam passage, whatever may be the load, and there being no dash pots, trip catches, etc., the gear is absolutely silent in working.

It is reasonably pointed out that the positive gear is practically immuned from risks of break down. An intricate gear, however successful in working, can never compare with one which effects the same results, but which is of simpler mechanism. The Turner-Pegg gear is especially characterised by its simplicity and solidity. All rod ends are plain "brass to brass" adjustments, easily set up and perfectly rigid. The "brasses" are of phosphor bronze, valve spindles of extra large diameter with phosphor bronze bush bearings spotted with white metal. An absolutely steam-tight joint is formed for the valve spindles by means of a large collar, forged solid with spindle, and pressing against a white-metal facing on the end of the spindle bearing. The governor controls the valves direct, without belt or bevel wheels, and has ample wearing surface; more especially the eccentric or cam sleeve. This encircles the

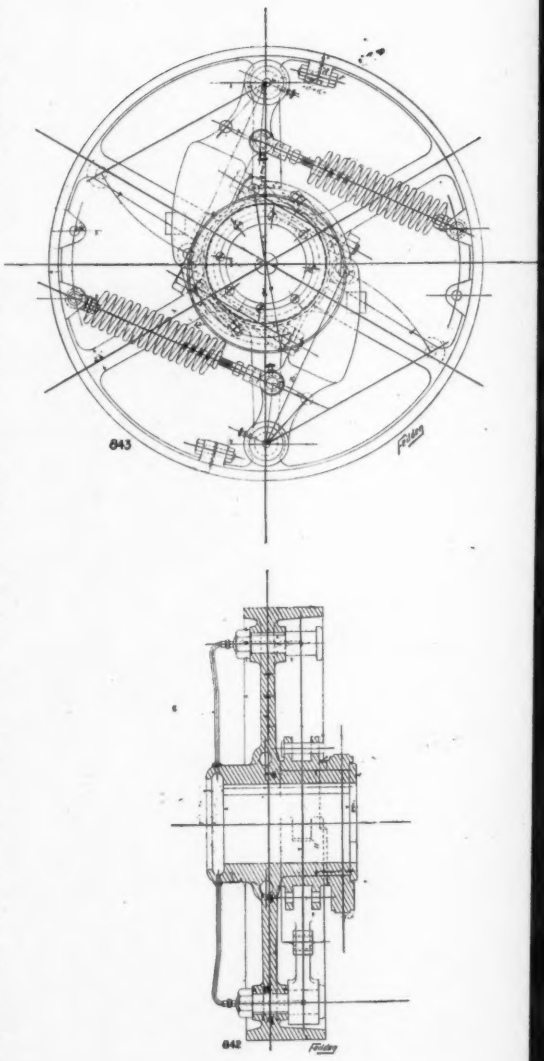
governor boss, and being of necessity of large diameter (in order to take the crank-shaft) has a great wear-resisting power. At the same time, it acts like the air vessel on a pump by absorbing all minor fluctuations on the part of the governor weights arising through small load changes. This sleeve, as the inventors point out, is adjustable and can be set to any desired resistance according as the changes of load are slight or heavy. Under normal conditions the governor controls the speed of the engine to within a variation of 2 per cent.

The Turner-Pegg Positive Gear has stood the test of practical experience, and entirely independent of laboratory tests. It has been working continuously on one engine since June 1898, without the remotest suspicion of a hitch; another, indicating about 130 h.p., has been running continuously day and night, shutting down for Sundays, since October 1898, with the same result. With regard to steam consumption, a trial has been made extending over some two months under, however, somewhat disadvantageous circumstances, owing to the boiler not being suitable for more than 70 lbs. pressure. In this case the engine was compound-coupled condensing, with cylinders 11 ins. and 18 ins. diameter by 20 ins. stroke, running at 120 revolutions. The mean steam consumption at a boiler pressure of 70 lbs. (an uneconomical pressure) came out in the course of three separate trials at a mean of 18·9 lbs. per i.h.p. per hour, including the steam used in the steam jackets. Further trials are about to be made at much higher pressures, the results of which are anticipated to prove of great interest to engineers and steam-users in general.

It may be expressed, finally, that the patentees of the Turner-Pegg gear do not place their reliance on their gear in respect to steam economy alone, although in that particular they claim their gear is equal to, if not ahead of, other Corliss gears. In economy of up-keep, they claim it is far superior to any of its competitors, and for that reason alone, if for no other, deserving of special attention.

Turner steam engines equipped with the Positive Gear are made in two classes, one of which is a long-stroke engine, suitable for pressures up to 140 lb. per square inch, and of a finish approaching *de luxe!* The other is a shorter stroke engine for not more than 100 lb., well-finished, strong and durable, but more adapted for work than display.

We are indebted to the courtesy of Messrs. E. R. and F. Turner, Ltd., of Ipswich, the makers of the engine and new gear, for these particulars and illustrations, which will no doubt be consulted with interest in this country and abroad.

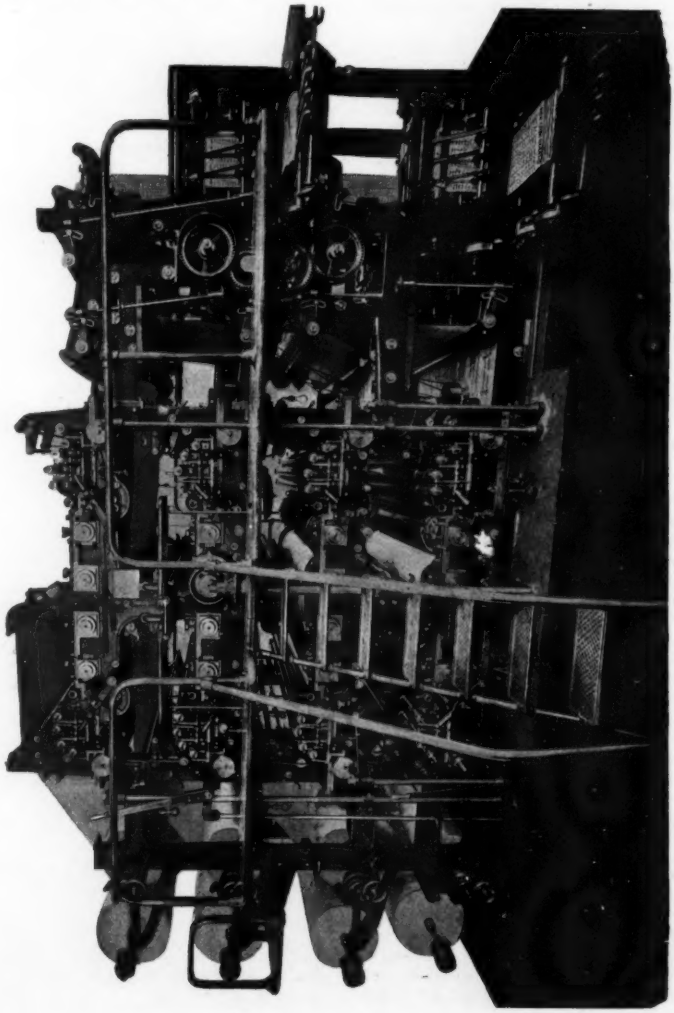


DETAILS OF POSITIVE GEAR GOVERNOR FOR CORLISS ENGINE.

THE GOSS STRAIGHT-LINE OCTUPLE PRINTING PRESS.

WHAT is known as the Goss Straight-line Octuple Printing Press has been in operation in the United States for a time, though it is still comparatively new in that country. The first printing press on the Goss principle has been recently installed in the office of the *Birmingham Argus*, which on that account is entitled to the credit of being, from a mechanical standpoint at least, the most up-to-date newspaper in this country. The *New York Herald* has two of these presses in operation, the last having been installed about two years ago.

The machine constitutes a new departure in printing engineering practice, and on that



THE GOSS STRAIGHT-LINE OCTUPLE PRINTING PRESS.

account is worthy of some detailed notice. Its general construction may be gathered from our illustration, by which, it will be seen, the machine is built in "decks" or tiers one above the other, thus economising floor space. The machine for the *Birmingham Argus*, though not so large as some in use in the United States, will print, paste, fold, count, and deliver in bundles of twelve at the rate of 48,000 copies per hour of a paper of from 2 to 8 pages, and at the rate of 24,000 per hour of from 10 to 32 pages

The machine is purely automatic, requiring assistance only in the feeding-in of the reels of paper as they become exhausted. The run-out of a reel does not stop the whole machine, as it is run as two separate presses, each part stopping independently of the other. This, as will be seen, must largely add to the productive capacity over that of a press that necessitates the stopping of the entire mechanism at every occasion for a halt.

The reels of paper are fed in from the rear. In the case of the *Birmingham Argus*, the web of the paper is 5 ft. 3 in. wide, which runs very rapidly through the printing cylinders, passes through an automatic pasting device, is automatically folded, counted, and delivered in bundles of twelve copies each.

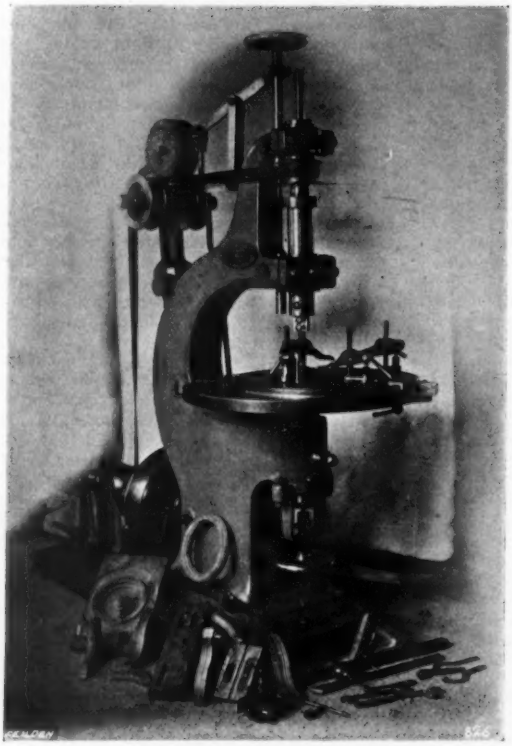
The feature that is chiefly distinctive of the Goss Straight-line Printing Press, however, and the one to which it owes a part of its title, consists in the fact that the several webs of paper are brought together in a straight line before reaching the folding attachment. The association of the four webs of paper, and the process by which the webs travel in a straight course from roll to folder, thus eliminating the angle-bar method of turning the web and deflecting it from its straight course to one at right angles, is entirely new. It is well known that a web of paper will withstand an enormous strain if brought evenly and equally, but that if even a slight strain be brought on it obliquely, the paper is liable to rip and break immediately. The angle-bar method, absent from the Goss machine, of associating the printed webs to complete the paper, causes the strain to be greater on one side of the paper than the other in passing over the turning bar, and the liability of breakage to the running paper, therefore, was greatly increased. The Goss machine, as stated, draws the web into and through the press in a straight course, with an even, equal pull throughout, that enormously lessens the liabilities of breakage, thus effecting a considerable economy and largely adding to the productive capacity of the machine. The straight-line principle also has another important consequence, as it dispenses with all the mitre gears necessary with machines standing to each other at right angles. In the press under notice, the driving gears are all one side and in a direct line, transmitting the power to the extremest point by the shortest distance. The association of the parts of the paper is effected in a very simple manner, without any mechanical device other than a pair of adjustable rolls to carry and connect them in proper register. The sections are imposed upon the press side by side, and after receiving the primary fold, the folded web is carried across and associated with that from the other side, and then pass together between the cutting cylinders, are cut off, folded again, and delivered together.

The motive power for the Goss press at the offices of the *Birmingham Argus* will be supplied by a gas-engine from Messrs. Tangye, and we are informed an addition of Linotype machines is being provided to cope with the increased amount of matter which will be printed in the paper.

√ NEW WOOD-WORKING MACHINE.

WE are pleased to be able to give some descriptive details of what is undoubtedly a mechanical invention of more than ordinary importance. The trenching machine invented by Mr. Shurmur, and made by Messrs. H. W. Cowley & Co., of Bolton, constitutes a distinct advance in wood-working plant, superseding the lathe in a large field of woodwork. The machine has been specially designed for all kinds of trenching, circular moulding, slot mortising, &c., and will do any character of work that can be done on an ordinary wall or other spindle.

The chief feature of the machine is the table on which the wood to be worked is clamped, and this is a most ingenious contrivance. It consists of a bottom circular table which can be turned round on its central pivot, locked in position, or raised or lowered to and from the cutter spindle as required. A second circular table is placed on the first, and this table can be pushed backwards and forwards horizontally in a guideway of the former at any angle to the spindle; or it can be turned round its movable central pivot so that the material fixed to it by the instantaneous clamps, shown in the illustration, can have cut in it holes the same size as the cutter, holes of any



NEW TRENCHING MACHINE.

diameter ; slots, rectangular, circular, oval, or other shapes of moulded panels ; grooves of any shape and similar work. All the work being clamped to the plate, the operator need not place his hands near the cutter, a point of considerable importance in view of the Workmen's Compensation Act. In circular mouldings, either concave or convex, the wood to be operated is fitted on a special table which revolves with it while the cutters operate on it. This ensures mathematical correctness in the radius.

It is obvious from the design of the machine that it is adapted to the performance of a multitude of varied uses, and that it deserves the notice of every woodworker who desires to get his work expeditiously and economically done.

❀

READERS of "FEILDEN'S MAGAZINE" are reminded that the Editor will be pleased to hear from them with advance particulars of any new machinery or specialities they may be bringing out or interested in.

Nothing mediocre, stale, or commonplace will, however, find room in these columns.

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WHEN ALL THE WORLD

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All further particulars on application to the head offices, Temple Chambers, Embankment, London, E.C.

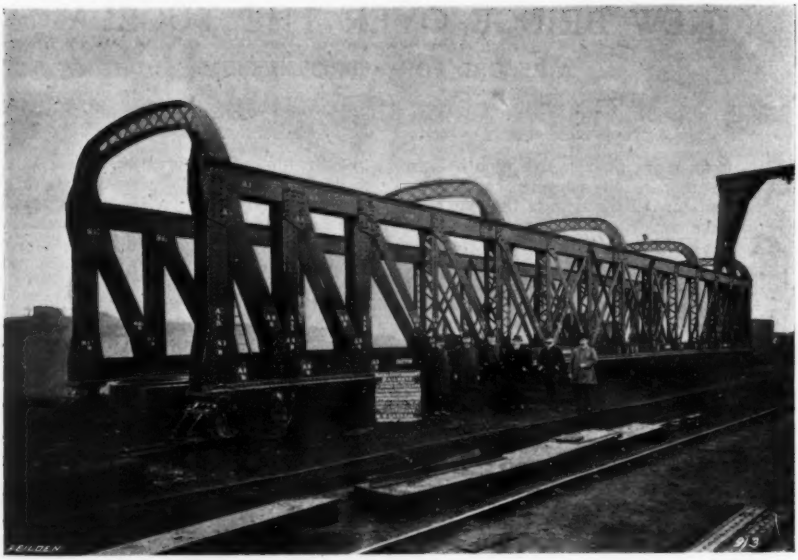
NEW BRIDGE OVER THE TUGELA.

A RECORD FOR A BRITISH FIRM.

A LITTLE more than twelve months ago the British engineering community was startled by the fact that the contract for the construction of the bridge over the Atbara River had been let to an American bridge-building firm, and as an outcome, alarm was taken at the apparent fact that English manufacturers were beaten on their own ground. The record accomplished by the Patent Shaft and Axletree Company, Limited, of Wednesbury, has, however, conclusively demonstrated that British workmen are not so slow or methods so antiquated as at one time seemed evident. When the bridges over the Tugela River at Colenso and the Blaauwkraus River at Frerewere destroyed by the Boers, the Natal Government caused plans to be drawn up for restoring the railway communication, and in the open competition—both in this country and America—which ensued, the directors of the Patent Shaft and Axletree Company secured the contract for both. The order was given out on December 21st, and the most stringent clause of the contract was that the first span should be handed over complete to the shippers in six weeks' time—viz., by February 1st. As a matter of fact the work has been done in twenty-three days, or, allowing for Sundays and the Christmas holidays, sixteen working days, and it is with pleasure that we are enabled to give two illustrations of the side and end views of the completed span.

The Colenso bridge will consist of five spans, and the Frere bridge of two spans, each span being 105 ft. The width is 16 ft., a similar distance separating the foot of the girders and the top of the arch bracing. Each span consists of two large lattice girders braced together with cross girders, a system of

NEW BRIDGE OVER THE TUGELA (END VIEW OF SPAN).



NEW BRIDGE OVER THE TUGELA (SIDE VIEW OF SPAN).

overhead bracing being also adopted. Each span will weigh some 105 tons exclusive of rivets, and 69,000 rivet holes have to be drilled. Siemens-Martin steel, manufactured at the Company's works, is used throughout, and the whole painted over with Docker's special "Hermator" oxide paint. Each bridge will accommodate a single line of railway of 3 ft. 6 in. gauge, and a further space at each side of 4 ft. 6 in. to serve for pedestrians or vehicular traffic.

The extent of the task is not altogether indicated by the mere mention of the dimensions of these spans, or of the length of the bridges as a whole. The Patent Shaft and Axletree Company have produced the bridge from the crude pig-iron. From the pig the steel has been made, and rolled into the requisite sections, and then made up to correspond with the templates, the construction of which in itself forms an extensive preliminary task. In a single span there are 53 tons of plates, 13 tons of bars, 26 tons of angles, and 13 tons of tees. The weight of the two bridges is 735 tons, and, in addition to drilling and rivetting, about 52,500 ft. of rough edges of plates, &c., have to be planed. When fixed up, each span has to bear a test load of 264 tons, and having satisfied that requirement is regarded as being equal to the carriage of ordinary traffic up to 130 tons. The steel is also subjected to a tensile test, and has to endure a strain of 27 to 32 tons to the square inch.

The Atbara bridge, which was supplied in six weeks, weighed 400 tons, and the accomplishment of such a heavy piece of work in that time was regarded as phenomenal. In this instance the first span has been completed in about a fortnight, with nothing but ingots in stock when the order was received, and it is anticipated that the remaining spans will be sent out at the rate of one each week. The work should, therefore, be completed in about eight weeks, or two weeks longer than the American "record." These bridges, however, weigh about 335 tons more than the Atbara bridge, the edges of the plates of which were not planed or finished. On this showing alone the comparison is a good one, but it can be carried even further. The Patent Shaft and Axletree Company are causing each span to be erected in their yard before being sent away. This process adds several days to the time within which the spans could be despatched, but it is more satisfactory, inasmuch as the directors are thereby absolutely certain that each is complete before it leaves the yard, and on arrival in

Natal has only to be bolted together and launched on the masonry piers.

The firm constructed the original bridges for the Natal Government Railways in 1877, but the new bridges are built to a different pattern, involving the making of new templates.

The Directors of the Company, of whom T. P. Lacy, Esq., J.P., is chairman, have taken a special interest in the construction of the bridge, and all employés, from the manager downward, have worked and are working at an exceptional pressure: the template staff working voluntarily right through the Christmas holidays.

Principals and workmen alike are to be congratulated on a result the accomplishment of which will sufficiently remove the stigma that has been cast upon the prestige of British bridge-builders.

❀ ❀ ❀

VOLUME I. OF FEILDEN'S MAGAZINE . . . .

We present herewith a reduced facsimile of the beautiful cover design for Vol. I. of FEILDEN'S MAGAZINE. This elegant production is carried out in gold and black upon an art green ground, and forms one of the most striking and unique illustrated book covers it is possible to conceive. As will be seen, it possesses an individuality entirely its own, and a character at once emblematic and patriotic. Those who have preserved their copies of the Magazine will want to have them bound up in this handsome case, and those who have no issues—or perhaps only odd ones—will surely require to procure them all for binding whilst the opportunity exists. We have had a considerable number of orders and enquiries, and have attended to all requirements up to date. Within a few days after receipt of any further orders we can fill them—as far as our supplies will go.

❀

We strongly advise all those who have not the back issues of FEILDEN'S MAGAZINE to place their orders for a volume without delay. We give prices below, and can safely say that in the time to come every volume will be worth twice as much as is now being charged.

❀

Vol. I. contains an Index showing nearly 1800 entries, and the volume includes several hundred splendid illustrations. It is truly a "Record of the World's Industrial Progress," the *crême de la crême* of engineering matter.

❀

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WORKSHOP PRACTICE

The attention of Workshop Foremen and Mechanics is directed to the notice on page 190.

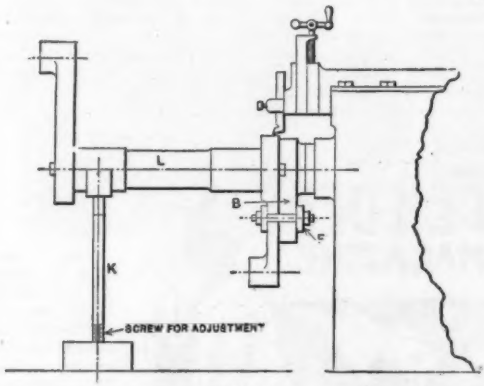


FIG. 1.

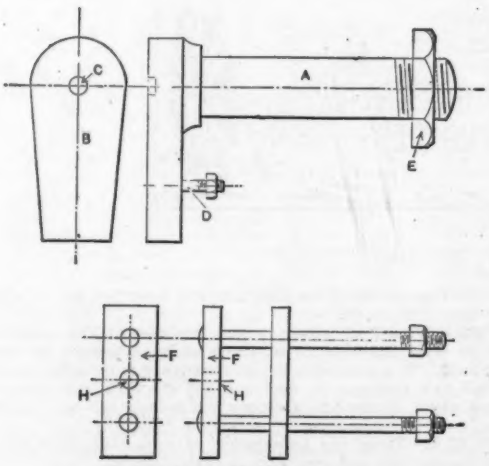
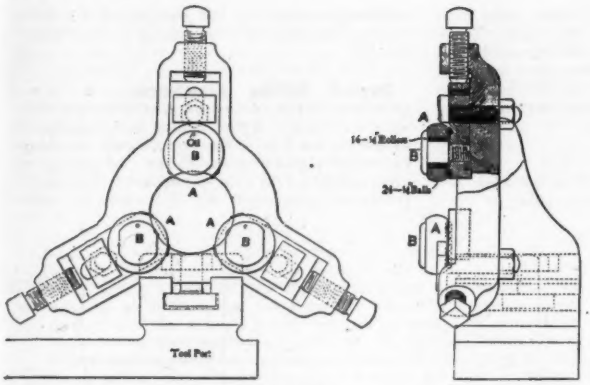


FIG. 2.—UNIQUE JIG.

Unique Jig.—A unique contrivance, for the purpose of shaping the round part of a locomotive rocker, has recently been devised. Originally these arms were milled off, but as the only available miller was a large and expensive machine which could be used to better advantage on other work, the arms were transferred to a slotter. Here, however, trouble was also experienced. The head had to be raised to such a height that only a very short stroke could be obtained. Much time, and consequently money, was consumed in adjusting the machine and setting up the work; a slotter is also an expensive machine for that class of work. The jig shown in the illustration was devised, and the work was transferred to a shaper. The advantages of this jig are, first, its rigidity; second, the ease with which work can be attached; third, only one nut to tighten in "setting-up" jig; fourth, the small amount of room taken up by the jig, which can be kept in the machine without being in the way of the machinist. All the work done where these jigs are used is piece-work, and as the rockers are now finished for 7½d. cheaper than before, it can be seen that the jig is fairly efficient. The shaper to which this jig is attached has the revolving feed attachment. The spindle *A* on the jig, Fig. 2, fits into the hole in this feed device and is fastened on the inside by a nut *E*. In the arm *B* of the jig, and in line with the centre of the spindle, a hole 1⅛" in diameter, and about 1" deep, is bored. This is used as a sort of female centre, into which a male centre *C* on the rocker arm fits. This locates the position of the rocker and insures a uniformity in the various rockers. On the back of the arm *B* a ¾" stud *D* is fastened, which goes through a hole *H* in the carrier *F*, and which holds it firmly in place. It is not necessary to remove the carrier to place a new rocker in position. A hinge in place of one of the nuts on the carrier would simplify it



PISTON-ROD ROLLER.

still more; but as all the arms are not of the same thickness, this is impossible, or at least not advisable. To support the weight at the extreme outer end of rocker a light stand is used, as shown in Fig. 1 at *K*. A jig of this kind, as can be readily seen, is very rigid and cuts $\frac{1}{2}$" in depth with $\frac{1}{8}$" feed can be readily taken.

◇◇◇◇

Centering Cylinders for Tracing and Turning.—A device for centering and facing-off the ends of large rough-cast cylinders, and similar pieces, used in one of the large American houses engaged in the manufacture of heavy machinery, is described in a recent issue of *American Machinery*. A cast-iron cross-piece, as in Fig. 1, with an adjusting screw tapped into the end of each of the four arms, was made, the ends of the screws being pointed so as to fit into four corresponding centering holes made in the casting. In the centre of the cross a hole $1\frac{1}{2}$" in diameter and $1\frac{1}{4}$" long was drilled, into which a steel oil-hardened centre was fixed so that there would be no getting out of line on account of wear.

A smaller hole was continued through the casting, so as to be able to replace the steel centre in case it should become necessary. These crosses were made so that they could take cylinders with a variation of bore of 3". For the facing-off and turning of cylinders that had been already bored, a device as shown in Fig. 2 was used. By means of this a great deal of time was saved in the centering of the work. It consists of a cast-iron disc turned to a diameter a shade smaller than the size of the bore of the work to be faced or turned. This disc was cored entirely through, with the exception of a thin connecting piece on either side.

In the centre of the disc a taper hole was bored, to which was fitted a tool-steel centre-piece, countersunk on one end to receive the centre of a lathe. After the disc had been placed into position on the work, these tapered centre-pieces were driven in the hole to receive them in the disc, just tight enough to spring the sides of the disc out, and thereby holding it firmly in the cylinder. The ends of the steel centre-pieces

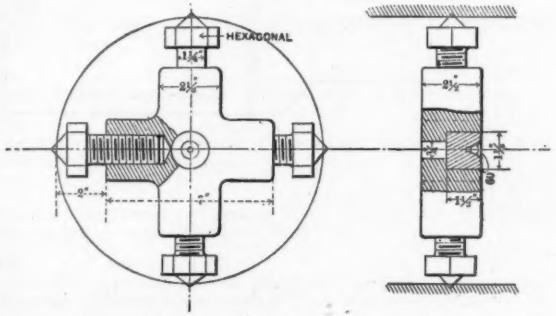


FIG. 1.

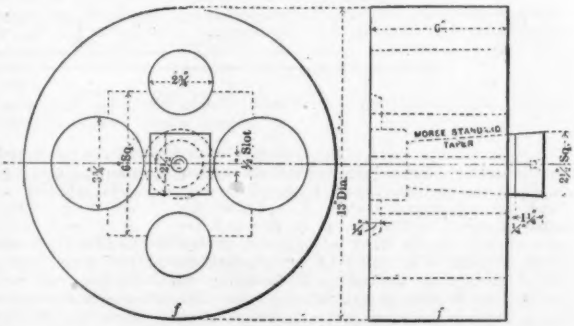


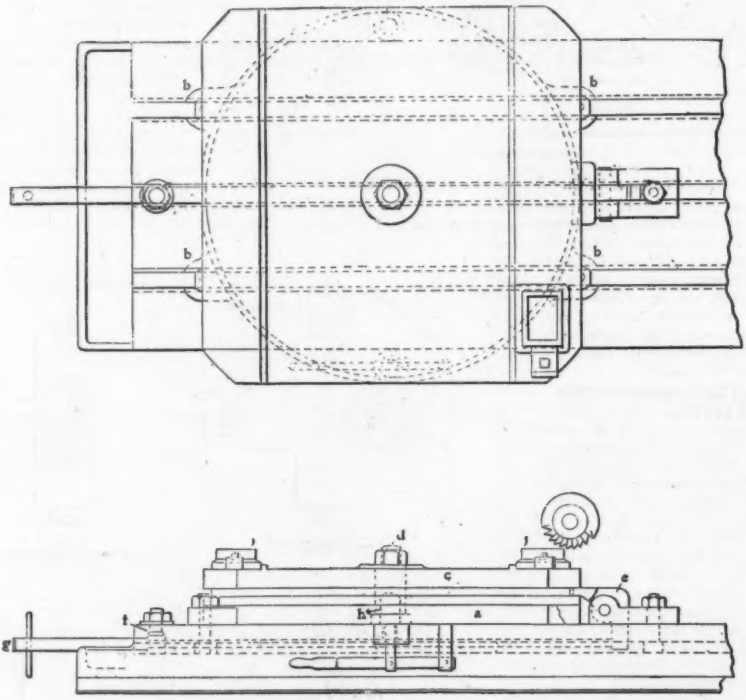
FIG. 2.

CENTERING CYLINDERS FOR TRACING AND TURNING.

were made square, so that a wrench could be applied to remove them from the discs. The discs were countersunk on the inside face to hold a stick of timber, which was placed between the two discs in either end of the cylinder to prevent them from closing in after the work was swung in the lathe.

A Piston-Rod Roller.—A form of burnisher or roller, which is becoming very popular in the United States on account of the cheapness of the process and the excellent results obtained, is illustrated on the previous page. In the illustration which we reproduce herewith, *A*, *A*, *A*, are the rollers mounted on the pins *B*, *B*, *B*, which are screwed into blocks fitted into grooves of the frame or tool. The rollers *A*, *A*, *A*, turn on roller bearings as indicated, there being 16 rollers ¼″ in diameter in each bearing. The side thrust, which in these tools is considerable, is taken up by 24 balls ¼″ in diameter which lie between the roller and the frame. The device, as is evident, is mounted in the tool-post of the lathe when being used and carried along by the carriage feed.

Duplex Milling Attachment.—A correspondent of the *American Machinist* describes what he terms a duplex milling fixture, designed to reduce the loss of time occasioned by taking the milled pieces from the fixture and putting in others ready for the cut. This loss of time, as he points out, is especially the case where the work is cast or forged, requiring separate bolts and clamps for each piece on account of unevenness.



DUPLEX MILLING ATTACHMENT.

In referring to the drawing above, *a* is the bed of the fixture (which is fastened to the platen of the machine by the lugs and bolts *b*), *c* is the table which is fastened to *a* by the stud, washer, and nut *d*, and adjusted to turn freely without shaking. *C* has a groove, turned as shown, to receive the end of the clamp *e*, which is in the form of a bell-crank lever. *F* is a T-bolt, drilled and tapped and clamped in place by nut. The rod *g* is threaded at *f*, and continues to lower arm of

e. *H* is a bolt with taper end, which is held in place by a spring, and fits in one of two steel bushings placed opposite in the table to serve as an index. *H* is operated by the lever *i*, and *j* is the work to be milled.

When the cut is finished, and the feed drops, the operator runs the platen back with his right hand until the work is clear, at the same time turning the rod *g* with his left, which releases the clamp *e*. He then draws the bolt *h* with his left hand on *i* and gives the table one half-turn, bringing the next piece of work into position to be milled, and runs it up to the cutter with his right hand, at the same time tightening the clamp *e* with his left, and throws in the feed. He has now the time required to make the cut in which to remove the milled pieces (the number of which will of course be determined by their size and capacity of machine), clear out the chips, and clamp in new ones.

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In the above section we are introducing a new feature to FEILDEN'S MAGAZINE, the purport of which will be to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is much more generally encouraged by employers in the workshops of the United States than in Great Britain; and, moreover, the American technical press also devotes special attention to ideas and improvements suggested by artizans. In introducing this section of the Magazine, the Editor invites skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which if accepted will be paid for. Whenever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for reproduction. Nothing will be too poor for a careful inspection.

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When the First Announcements
of FEILDEN'S MAGAZINE went forth, people were sceptical as to the Proprietors being able to attain what they aimed at.

It was acknowledged
that the first issue exceeded expectations. Performance was even better than the promise.

Then it was predicted
by some wiseacres that it could not be kept up. It was a "first issue;" better than any that had preceded it, it was true, but still only a "first issue."

But subsequent issues
justified all pretensions and stifled the remarks of carping critics. It has now been freely acknowledged everywhere for months past that FEILDEN'S MAGAZINE

Has established a record.
The unanimous opinion of the British and foreign press, the world's leading engineering and scientific authorities, the industrial and commercial community and the public generally, is, that FEILDEN'S MAGAZINE is

The best of the best.
What more could be wanted? The Proprietors, however, are not satisfied. Busy, active brains have been at work night and day on plans to see how the already very high standard of excellence of the Magazine can be still further enhanced. As a result

1900 will see innovations
of a character which will give this Magazine a greater value both to the technical and general reader than any other publication extant. It has already

The largest genuine *SALE* circulation
of any monthly industrial-engineering magazine in the United Kingdom or abroad. The Proprietors aim at making it double that of any other high-grade technical journal. It can and *will* be done.

Extensive arrangements are in progress
to that end. Meanwhile the Proprietors advise all the present readers to recommend their friends to take and *preserve* copies of FEILDEN'S MAGAZINE. The new matter which will shortly be introduced will cause all back numbers to be sought for with increasing interest for binding.

Watch the pages from cover to cover.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION FROM ALL SOURCES.

CIVIL AND MECHANICAL ENGINEERING.

A Modern Cement Works.—The new works of the Nazareth Portland Cement Company at Nazareth, Pa., have been recently completed and possess a number of features of interest. An attempt was made when the plant was constructed, about a year ago, to utilize the heat in the gases from rotary kilns for generating steam in the boilers of the power plant. The gases from each kiln were led to a vertical boiler, which could also be fired with coal on an ordinary grate if the demand for steam required it. A chimney carried off the gases from each boiler. When the plant was put in operation, trouble with the draught was encountered, so the capacity of the kilns for burning clinker was greatly reduced. This was due to the fact that when the grates were fired with sufficient coal to work the boilers at the requisite pressure, a certain amount of back pressure was created in the kiln, which naturally retarded its own fire. When the present manager of the works took charge, it was decided to give up the attempt to utilize the heat from the kilns, to substitute coal in place of oil as fuel for them, and to make other changes of importance.

The Nazareth works, which now have seven rotary kilns, giving the plant a capacity of about 1,000 barrels a day, are situated on a hillside close to the Bangor and Portland Railway Company. The kiln room, the raw material and finishing machinery form part of the main building, in an extension of which are the engine room and machine shop. Coal is conveyed in trucks on a trestle line and deposited in a heap by the side of the coal mill at one end of the kiln room. A railway track runs on each side of the stock house, which is 250 feet long, thus giving 500 feet of shipping platform. Taken as a whole, the works may serve to illustrate the thoughtful care now bestowed on all industrial establishments in the United States.

A Hint to Birmingham.—Consul Martin, of Amherstburg, desires to call the attention of manufacturers of iron and brass bedsteads to the opportunity offered in Canada for the establishment of one or more factories for their manufacture. Many of the dealers throughout Canada are at the present time buying their iron and brass goods in the United States and paying the duty of 30 per cent., while the iron and brass from which they are made are free of duty under item 617 of the Canadian Customs Act of 1897, viz.: Tubes, rolled iron, not welded or joined, under 1½ in. in diameter; angle iron, 9 and 10 gauge, not over 1½ in. wide; iron tubing, lacquered or brass covered, not over 1½ in. in diameter—all of which are to be cut to lengths for the manufacture of bedsteads, and are to be used for no other purpose; and brass trimmings for bedsteads when imported by or for manufacturers of iron or brass bedsteads to be used for such purposes only in their own factories, until such time as any of the said articles are manufactured in Canada.

A Smart Engineering Feat.—Americans have not an entire monopoly in the rapid production and despatch of manufactured goods. The War Office, we hear, recently required for immediate shipment to South Africa the following narrow-gauge railway rolling and other stock: two locomotives, five miles of railway, one mile of curved railway, 30 sets of points and crossings, 24 ballast wagons, each to carry 2½ tons; 15 eight-wheeled bogie wagons, each to carry guns and gun carriages, weighing six tons; and two special bogie brake wagons. Each wagon was to be provided with brake, with central spring buffer and draw gear, and all were of new and special design. Manufacturers, whose tenders were invited, were asked to state the shortest time they would require for delivery, time being the chief factor in the disposal of the order. The tender of Messrs. Kerr, Stuart, & Co., Ltd., of London, whose works are at Stoke-on-Trent, was accepted, their specified time for delivery being ten working days. The whole of the order was completed well within the time named.

Gas-driven Well Pump.—A deep well pump using a gas or gasoline motor, instead of a steam cylinder, has been introduced recently in the Pittsburg district. It is made in two sizes, 1½ h.p., requiring about 25 ft. of gas per hour or its equivalent in gasoline, and 3 h.p. Three of the latter size, recently installed near Sewickley, Pa., are used on wells 150 ft. deep, and deliver water at a distance of 600 ft., and an elevation of 100 ft., the capacity of the pumps being probably about 6,000 gallons in 10 hours. The pumps are made by the Downie Pump Company, Downieville, Pa.

High-Speed Gas Engine Test.—We have received the records of a test recently made by Professor W. H. Watkinson of the high-speed gas engine illustrated and described by us in our last issue. The following summary gives the chief data. It will be noted that the gas consumption per brake horse-power registered is extremely satisfactory, though the engine at the time was not working at full load :—

Duration of test	73 minutes
Diameter of each of the four cylinders	5½ inches
Stroke of each piston	8 ,,
Average number of revolutions per minute	386
Effective diameter of brake wheel ...	42·25 inches
Effective load on brake	146 lbs.
Average mean effective pressure in the four cylinders	57·5 lbs.
Total missfires per minute	5
Brake horse-power	19
Indicated horse-power	25 (nearly)
Mechanical efficiency at above load ...	76 per cent.
Gas consumed per hour (not including ignition gas)	443·8 cubic feet
Gas consumed per hour per b.-h.-p. ...	23·3 ,, ,,
,, ,, ,, ,, ,, i.-h.-p. ...	17·75 ,, ,,
Pressure of gas at meter, by water gauge	2·25 inches
Temperature of gas at meter	49 deg. F.
Weight of water sent through jackets per minute	33·3 lbs.
Average rise in temperature of cooling water	56 deg. F.
Amount of heat lost to cooling water per minute	1,865 B. T. Units
Amount of heat converted into indicated work per minute...	1,066 ,, ,,
Heat supplied per minute on the assumption that each cubic foot of gas gave 700 B. T. U.	5,180 ,, ,,
Per centage of heat converted into work	20
,, ,, ,, ,, lost to cooling water	36
,, ,, ,, ,, ,, ,, exhaust (by difference)	44

A Novel Form of Steam Engine.—A simple form of steam engine devised by Prof. Elihu Thomson has been attracting much attention. The engine, which is of primitive appearance, somewhat resembles a gas engine, but the outward stroke of the piston is a working one. Prof. Thomson's engine has four cylinders, each 2½ ins. in diameter and 3 ins. stroke, all single acting and worked single expansion, and therefore, being virtually four small engines, each of a little over one horse power capacity, the output of the whole is about five horse power The economy obtained with this small machine reached the surprising figure of 20½ lbs. of water per horse power per hour, the output being measured by a dynamo driven by the engine, the amount of water per indicated horse power being undoubtedly less than 20 lbs. The steam pressure used was between 160 and 200 lbs., but there was a considerable and variable degree of superheating, the engine being worked at times with the steam pipe red hot. It has been stated that Serpollet of Paris has designed a steam motor on similar lines.

British Bridge Building.—It has become known that American firms have been making strenuous endeavours to obtain the contract for the new bridge over the Tugela river at Colenso. It is notorious that there is scarcely any profit to the Americans in transactions like the Atbara bridge, but that they lend themselves remarkably to effective advertisement there can be no doubt. It is satisfactory to note that the Tugela and Frere bridges have been secured by a British firm—the Patent Shaft and Axletree Company. The bridge requires seven spans, and the material is wanted as soon as possible.

American Locomotives.—The Baldwin Locomotive Works of Pennsylvania, U.S.A., are said to have built 104 locomotives in twenty-six working days in October, an average of four a day. In November, which contained twenty-five working days, the record was 92 locomotives. The establishment now employs 7,250 men, and the present year for tonnage of output will far exceed any previous twelve months in this great plant. Although the works turned out 946 locomotives in 1890, the engines then were much smaller than they are to-day. Earlier in the present year there was a pressure of foreign trade, the firm having always done a very large export business, but domestic railroads are just now claiming a greater share of attention. The sensational orders for engines for the English roads have mostly been shipped. Large Russian contracts seem to be pending, however, and the capacity of the works is being taxed to the utmost. Despite the fact that all kinds of labour-saving machinery driven by electricity and other forms of power are being introduced into locomotive manufacture, the number of men employed at the plant has never been so great as it is to-day.

Engineers and Machine Tools.—An interesting paper was recently read by Mr. A. R. Bellamy, before the Manchester Association of Engineers, dealing with the important subject of Machine Tools. In the course of his paper the author stated that it would be more satisfactory if engineers' tools were sold with some form of efficiency guarantee, as is the case with boilers, engines, dynamos, &c., instead of open specifications as to the amount of work they would do. In criticising the design of various classes of machine tools, Mr. Bellamy stated that with regard to lathes there was a lack of uniformity in design, and thought that standard methods should be adopted. In most lathes, he stated, the difference was much too great between the last single speed and the first geared speed. With respect to changes of feed, he thought all these should be done by means of gears which could be altered by the simple movement of a lever. In most large lathes the slide rest was too high, and did not permit the use of a large section of steel for the tool. It would be of considerable convenience to users if lathe makers would adopt a standard thread for the face plates, and arrange a standard set of sizes and tapers for the loose centres. In planing machines the two-belt drive was much more effective than the single drive. With respect

to shaping machines, the method of changing the stroke was usually one that caused great waste of time. He thought the change of stroke should be altered at the front of the machine. He had not much to say about drilling machines, except that he thought even the simplest drill press should be made to reverse, and that all radial drills should have a proper power motion for raising and lowering the arm—something a little better and quicker than putting on and taking off a belt. The worst fault with most tools, Mr. Bellamy stated, was that they were short of power. As a rule the belt speed was too slow and the gearing too weak. If they took almost any tool and adapted it for the electric drive, where there was no slip of belt, they would find it was only a question of time before the gearing began to give trouble and ultimately broke down. All large machines that had heavy parts requiring to be moved should be fitted with a power motion to such parts. Except in a few cases, quick "band traverse" should be done away with and quick power traverse substituted. He also found that lubrication in machine tools was, as a rule, very defective. All parts needing lubrication, should, where possible, be fitted with proper lubricators, and parts that were difficult to get at should have the oil led to them by pipes coming from one common oil well, as was the case with modern high-speed engines. It is very desirable, says the author, that every tool should be thoroughly tested before it left the makers' works—not merely put to work, but properly tried with some of the work it would be required to do. As to design, with the exception of milling machines, and a few special tools, most engineers' tools required bringing up to date.

Automobiles in War.—It is nearly twenty-five years since the French army authorities adopted traction-engines. These are, however, now being discarded owing to their heavy weight not permitting them to be taken over many of the country bridges, and in 1897 it was decided to give the Scotte vehicles a trial; and these tests were continued in 1898, and again last year, until now it has been definitely decided to introduce them into the French Army. The Scotte tractor weighs from five to six tons, and does the work that was formerly performed by thirty-two horses; not only so, but the absence of the horses decreases the length of the train by almost one-half, and reduces the attendant *personnel* from 180 to only 120. The speed of the Scotte road train is much faster than that of traction-engines, and as there are no stops necessary for changing or resting the horses, the journey undertaken can be performed in a minimum of time. Twenty-five of these engines can provide an army of 60,000 men, 60 miles distant, with cartridges in 18 hours. They can also transport 50 "cannons of 24," weighing 24 tons each, a distance of 10 miles in a single night. If the Prussians had had such engines in 1870, they would not have required to wait three and a-half months before getting their guns into position for the siege of Paris. According to Moltke, they had to bring 960 waggons and over 2,000 horses from Metz for the purpose. Traction engines used by the British army in South Africa for hauling artillery and supplies, weigh 15 tons each, and will haul 40 tons of load. Thus compared with the Scotte tractor their weight is more than double, their carrying capacity 20 per cent. less, and their speed 50 per cent. less. It is to be hoped that our military authorities, who have apparently declined to inaugurate trials with motor-cars on their own account, are not entirely ignorant of what is being done in connection with the introduction of automobiles in the armies of the Continent.

A Remarkable Bridge.—The bridge across the River Sarthe, planned in the form of the letter X, designed and erected by Mr. Harel de la Noe, chief engineer of bridges and roads, was completed in 1898. The most remarkable feature of this bridge is not its plan, but the extremely low price at which it had been erected. The bridge covers an area of 5,382 square feet, and the amount available for its construction was only £1,800. The expense of bridges of a similar character in the vicinity has ranged from 20s. to 32s. per square foot, while the outlay in this case had to be limited to about 7s. per square foot. As a matter of fact, the entire cost was only £1,320, or less than 5s. per square foot. The use of so-called "armoured concrete" is rendered possible by the fact that the co-efficients of expansion for iron and concrete are approximately the same, that there is perfect adhesion between the concrete and the metal, and that concrete can readily accommodate itself to the amount of dilatation which the ironwork has to undergo. Upwards of 21 tons of old rails and over 80 tons of cement were employed in the structure.

Motor Fire Engines.—A firm of manufacturers in France has recently built a self-propelled fire-engine, which can develop a high speed for short runs. The power is furnished by an oil motor, with four cylinders at the back of the vehicle parallel to the axles. The piston-rods are connected by cranks to a shaft which carries on either end a fly-wheel. This shaft transmits the power of the engine, either to the wheels or to the pumps, by means of gears and chains. The pump, placed directly behind the driver's seat, runs at 180 revolutions per minute, absorbing 10 h.p. and delivering 150 gallons per minute. The pressure in the air cylinder rises to 114 lbs. to the square inch, sending a stream to the height of 120 ft. The new engines weigh 1½ tons, and have been tested successfully by the Paris fire staff.

MINING AND METALLURGY.

Alloys of Iron and Nickel.—Mr. R. A. Hadfield, recently read a paper before the Institute of Civil Engineers on "Alloys of Iron and Nickel," which is of great value. The effect upon iron of

gradually increasing amounts of certain added foreign elements has already been investigated by the author in experiments upon the mechanical and physical properties of alloys of manganese, silicon, aluminium, and chromium, both in the cast and forged conditions. In the present paper there are given the results of a similar investigation of the alloys of iron and nickel. In a research of this nature it is important to avoid as far as possible the disturbing influences of a second foreign element, especially carbon. This is not easy, for, although in several classes of alloys it is not impossible to obtain alloys low in the chief disturbing element, carbon, the alloy must be sound and free from honeycombs, and it must be malleable when hot. In the series now described the alloys were sound and free from blow-holes; they were well melted, of uniform composition, could be readily forged, and generally presented characteristics which enabled them to be submitted to the same comparative tests as the author's previous series. The chief disturbing element, carbon, is low and varies but little. The other elements present were normal and probably not of much influence.

A Novelty in Steel-making.—Last year in the crucible house of the metallurgical department (of University College, Sheffield) there was melted and cast probably the most expensive steel ingot that has been made in Sheffield. A steel was required to contain 22 per cent. nickel, 3 per cent. palladium with carbon practically nil; 12½ lbs. of 25 per cent. nickel steel scrap were charged into the crucible and clear melted; then 6·32 oz. of palladium sheet (value £60 14s.) were added to the charge. As dead mild steels occasionally find their way through the bottom of the crucible before they are ready to pour, the final stages were watched with almost breathless interest. The whole operation was, however, successfully completed, and the ingot rolled and drawn into wire. The cost of this experiment was not, of course, defrayed by the College Funds.

Davis Coal-Cutting Machine.—The Moira Colliery Co., of Ashby-de-la-Zouch, Leicester, have introduced the long-wall system of coal-cutting machinery; the electric plant, which has been provided by Messrs. John Davis & Son, of Derby, developing considerably over 120 horse-power. The machine is on the Jeffrey system.

Iron and Steel Plant.—A paper on this subjcet was read before the Staffordshire Iron and Steel Institute, Dudley, December last, by Mr. Harry B. Toy:—"In these times of American and other competition (he said) it is doubtless the duty of all connected with the iron, steel and allied trades of the Midland Counties to exchange views upon matters of detail, and combine in their efforts to maintain that good reputation for quality and finish which has been enjoyed for so many years. The truth now is well established, that for many purposes steel has superseded iron, but I firmly believe that if the heads of departments in our ironworks would study more closely the questions of economy of production, and improve their plants by judicious expenditure, the iron trade of this district would die a much more lingering death than is frequently depicted. There is another question which, although it has no direct bearing upon the title of this paper, very seriously affects, not only the developments of any new industry in the Midland Counties, but is gradually compelling manufacturers either to discontinue an old-established business, or seek at very great cost some more convenient site at the coast or elsewhere. The question to which I refer is the railway rates, and if the members of this Institute could in any way prevail upon the railway companies to make a concession in their rates from the Midlands to our shipping ports, they would not only benefit themselves, but would confer a great blessing upon many other branches of industry in this district. It is not my intention to recommend all ironworks proprietors to dismantle their existing plants and replace them with something quite different; but to make the necessary modifications to those details which seriously affect the cost of production, and which in many cases may be done at a small expense." After these preliminary remarks the author of the paper described what he considered to be an economical plant for producing approximately 1,000 tons per month of merchant and guide iron bars.

A Suggested Source of Platinum.—Owing to the demand for platinum for "leads" for incandescent electric lamps and other industrial purposes, the supply of this metal has not increased in a degree proportionate to the demand for it. Numerous reports, however, of new discoveries abroad of platinum, iridium, and osmium have been made, and in response to an inquiry the following information about these metals has been furnished by the State Department at Washington, D.C. A number of consuls have investigated the subject, and the reports from South America and Canada show that these metals do not exist in paying quantities in either of these districts. Throughout British Columbia they have been found scattered quite widely, and there is a general impression that they may be found in quantities which will be of value, but there is as yet very meagre information concerning them.

The Colour of Gems. — According to Tschermak, the formation of the colour of precious stones and other minerals, is not easily explained in the majority of cases. The dye-stuff contained in them may belong to an organic as well as inorganic compound, but almost always its quantity is so small that it does not suffice for a chemical analysis. In the mineral, zircon, which is much used as a gem, especially under the name of hyacinth, the yellow, green, red or brown colour can be ascribed to the presence of

nitrogen; and the same thing has been proven for the well-known smoke quartz, which is very often erroneously called smoky topaz. The origin of the colouring of the amethyst has not been determined as yet, but the opinion that it was due to the presence of a compound of sulphocyanide with iron, has been found to be wrong. In many minerals, the colour is caused by the presence of chrome. This has been a long-established fact as regards certain varieties of garnet, spinel and diopside (a variety of augite). But other highly-prized gems owe their colour to chrome, as the red and violet spinel, the ruby, the sapphire, the oriental amethyst, the green zircon, and the topaz of Villarica, Brazil. In the ruby and the sapphire, it is true, chrome could not be discovered direct, but it was established in the opposite way, that the combination of the elements constituting the said gems and potassium bichromate produces colourless metals on the one hand, but also red, blue, yellow and green ones. Thus, numerous other examples might be cited in which the cause of the colouring of materials might be ascertained, but a much larger number of coloured minerals, whose colour the chemists have not yet explained.

Potassium Mining near Hanover, Germany.—The geological features of the country around Hanover are of rather complicated nature owing to the severe dislocations which the strata has undergone. However, a general idea may be found from the following:—To the north, south, and east of Hanover the alluvial sands stretch far and wide, but to the west there are occurrences of the Chalk, Jura and Trias formations. The chalk formations consist chiefly of the lower Senon and the Jura of the lower brown, Jura and Lias. Of more importance is the Trias formations—the lower Trias or New Red Sandstone—which builds the hanging wall to the salt formation. The New Red Sandstone occurs on the Benther Mountain, the upheaval of which is said to have occurred about the middle of the Dogger period. In the neighbourhood of this mountain many deep borings have been put down to locate the potassium salts, and with more or less success. But a peculiar thing about the potassium finds is that they greatly varied one from another not only in depth but also in composition; also it seemed the richer the salts the smaller the layers were; in fact, as Professor Kloss said, the potassium salts of the Hanover district occur in nests or lenses and not in regular layers, as we have in the celebrated formation of the Stassfurt, and on this account may be successfully mined. Another geological difference between the districts of Stassfurt and Hanover is, concerning the so-called "younger" and "elder" rock-salt. In the former districts the potassium salts are found between two layers of rock-salt. The upper layer is called the "younger" and the lower the "elder" rock-salt. These two layers vary in composition one from another. The younger rock-salt contains a percentage of potassium, whereas in the elder it is not so marked; also the elder is known by its so-called years' rings. These are layers of anhydrite at regular intervals between the rock-salt. In Hanover district up to now we have, so far as the writer knows, not yet met with the elder rock-salt, and on that account one might think that if the borings were sunk deep enough they would come in contact with more potassium salts and the elder rock-salt, but this would likely be too deep to insure a profitable mining.

Hulam Coal Company.—Important developments in connection with the Durham coal trade are shortly to take place upon the opening out of the new coast-line between Hartlepool and Seaham Harbour. A number of the principal manufacturers on Tees-side have formed a new company to be known as the Hulam Coal Company, with a capital of £400,000, to develop the largest virgin coalfield in the county of Durham, part of which lies two and a half or three miles out under the sea, between Hartlepool and Seaham Harbour. The royalties have been taken out, and of the £400,000, something like £250,000 has already been subscribed by the gentlemen interested, while the raising of the other amount is only a question of a few weeks.

Chatillon-Commentry Company.—A bore-hole, which it is intended to put down to a great depth by the diamond method, has been undertaken at Villerval, in the French department of the Nord, by the Châtillon-Commentry Company, and has now attained 150 m. (82 fathoms), after having passed through 140 m. (459 ft.) of cretaceous measures. A declaration has also been made to the Administration des Mines by the Société des Aciéries de Micheville of its intention to put down two holes to the south of the Pas-de-Calais coal basin. Other iron-smelting companies in the east of France, who are fearing that their supplies of German coke will fail them before long, and are naturally anxious to ensure their supply, have made arrangements to put up coke-ovens, not only in their own district, but also in the Pas-de-Calais, especially at Boulogne and Pont-à-Vendin, choosing this last named town because of its being provided with both railway and water communication.

ELECTRICAL ENGINEERING.

Wireless Telegraphy.—Prof. Reginald A. Fessenden and his assistant, Prof. Kintner of the Western University of Pennsylvania announce that they have constructed a receiver for wireless telegraphy that is two thousand times more sensitive than the so-called "coherer" of the Marconi system. In referring to this discovery, Prof. Fessenden states that they were as yet not able to realize the full limit of their invention; but since Marconi had demonstrated that with his system messages could be sent over 90 miles, by the new device it would be possible to send messages across the Atlantic with poles less than 200 ft. high.

Aluminium Wire.—Some practical tests regarding the use of aluminium for overhead wires are being made in Chicago, in connection with the fire-alarm service, by Mr. E. B. Elliott. Spans of aluminium wire and new copper wire have been erected in places near railway tracks where they will be exposed to the fumes from the locomotives. The samples of the aluminium and copper wires employed were tested and the following results obtained. The gauge of the wires was No. 10 S.W.G. The copper wire was hard drawn and resisted 55 twists in 6 in. before breaking. The breaking weight was 515 lbs., with an elongation of just over 3 in. in 5 ft. length. The wire weighed 173 lb. per mile. The aluminium wire of the same gauge resisted 27 twists in 6 in. The breaking weight was 275 lbs., with an elongation of 1¼ in. in 5 ft. length. The weight of the aluminium wire per mile was 51½ lbs. Thus, although the copper wire resisted twisting and gave greater elongation than the aluminium, the breaking weight of the aluminium wire was more than half of the copper wire of the same size, while the actual weight of the wire was less than one-third.

Electrical Time Service.—The city of Carlsruhe, in the Grand-Duchy of Baden owns since last year an electric installation for the transmission of the exact time, which has so far given complete satisfaction. The clocks operated by electricity number 84, which are distributed over six lines. A normal clock, furnished with a movable contact, sends alternating currents at intervals of one minute, which push the hands forward one minute each time. The service at the central station is furnished by a battery of ten elements with carbon cylinders. The lines are overhead lines, the earth completing the circuit. The expenditure for the complete installation amounted to £3,360. For private clocks the city charges £1 5s. annually for the first clock, and 10s. for each additional clock.

Atmospheric Electricity.—The problem of utilizing atmospheric electricity for practical purposes ever anew tempts experimenters since the days of Franklin, and it is not unlikely that their perseverance will ultimately be rewarded by success. Of recent years it was above all Prof. Dolbear who, in 1879, experimenting with kites, attracted some attention by establishing the fact that intelligible telephone signals could be sent between kite-wires separated by considerable distances. A patent was obtained by him in 1886 on this method of sending messages, but on the whole his experiments remained without practical results. Lately, however, Prof. Alec. G. McAdie, of the United States Weather Bureau, has resumed kite-experimenting with the view of ascertaining the effect and intensity of atmospheric electricity, and is said to be sanguine in anticipating the utilization of the electricity contained in the air as a motive power, in the very near future. In this view he is supported by Mr. William A. Eddy, who, moreover, appears to have obtained already some practical results as far as wireless telegraphy is concerned. This experimenter has come to the conclusion that a kite-wire would be far better adapted to catching electrical oscillations in the atmosphere, than Marconi's wires attached to poles driven in the ground. He, moreover, claims that if the two vertical points of sending and reception extend high enough into the air, enough electricity will be obtained from the atmosphere, even in a clear sky, to do away with the batteries now used. He has devised a sparking apparatus which, when attached to a kite and sent up four or five hundred feet can be made to emit sparks by means of atmospheric electricity, at one second intervals, or even more rapidly, and believes that this might advantageously be used for war-signalling.

The Nernst Lamp.—An invention which represents a real progress in the construction of electrical incandescent lamps is due to the genius of Prof. Walther Nernst, of the University of Göttingen in Germany, a young man who is considered an authority on applied chemistry, and well known as an original thinker. The efficiency of an incandescent body depends upon the temperature to which it can be safely raised. In the ordinary incandescent lamps, the slender carbon filament which is enclosed in a hermetically sealed glass bulb, from which the air has been expelled, will stand only a definitely limited temperature, and its efficiency varies from 3 to 5 watts per candle. Prof. Nernst endeavoured to find an incandescent substance that would stand a much higher temperature than carbon fibre, and would be less sensitive also to variations of pressure, while at the same time it would work, if possible, without being suspended in a vacuum. In his experiments he struck upon a combination of oxides of thorium zirconium, cerium, and other so-called "rare earths," such as are used in making the mantles for incandescent gas-lights of the Auer von Welsbach type. From these oxides, combined in proportions kept secret, he constructed a rod 3 or 4 in. in length, secured by metallic attachments at either end, and enclosed it in an open glass globe. This combination of oxides is capable of withstanding a very high temperature, but it is at the same time, when cold, a non-conductor of electricity, and becomes an electrolyte only when heated to a certain temperature. It will bear pressures which would immediately destroy an ordinary carbon filament, and as the luminosity depends upon the temperature, Nernst's composition produces a given quantity of light far cheaper than the ordinary carbon filament lamps. The inventor claims that its consumption is but 1·5 watts per candle for large lamps, and 1·6 watts for small lights or low pressures. One of its peculiarities moreover, and one which renders it especially valuable, is that its light has almost exactly the same spectrum as sunlight, and is the only artificial light so far invented that permits the matching of delicate colours with practicable certainty.

On the other hand, however, Nernst's lamp, as

Mr. Frank H. Mason, U.S. Consul-General in Berlin, in his excellent report on the invention to the State Department points out, has in its present stage of development two grave defects which seriously restrict its commercial value for the moment. The first of these is that the rod of refractory oxides does not become incandescent by merely turning on the current, but must be previously heated, for which purpose a small spirit-lamp is employed, which must be lighted with a match and turned out when the electrolyte has become hot and begun to glow; and secondly a heater in the form of a coil surrounding, but not touching, the incandescent glower. This heater is supplied by the current from the moment it is turned on, and is so arranged that when the rod has begun to glow it is automatically cut out of the circuit and relapses into disuse until needed again to light the lamp. Besides, however, the life of the incandescent glower if operated at a temperature displaying its best efficiency, *i.e.* about ½ of a candle per watt, does not exceed 300 hours, while the carbon filament in the bulb lamps is good from 600 to 1,000 hours. All these, it is true, are drawbacks, but there is little doubt in time they will be removed, and meanwhile, at all events, Prof. Nernst's lamp represents the only real and striking improvement that has been made in the construction of electric incandescent lamps within the last ten or fifteen years.

The Clark Cell as an Electrical Standard.—In the December issue of the *Physical Review*, an article is contained on the absolute determination of the E.M.F. of the Clark cell by Messrs. H. S. Carhart and K. E. Guthe. The determination was undertaken in consequence of the new value of the electro-chemical equivalent of silver recently made by Messrs. Patterson and Guthe. The experimenters employed for the purpose the electro-dynamometer constructed in 1897—98, the cells of which are of the Rayleigh H form, as modified by Kahle, and do not differ among themselves by more than one part in 10,000. For the purpose of measurements the two Clark cells were connected in series. Their E.M.F. was not balanced directly against the fall of potential power over the manganic resistance. Instead of this, the E.M.F. of the cells was first compared by Poggendorff's method against the fall of potential over a secondary resistance, while the current was so adjusted as to balance the torque of the phosphor-bronze wire of the electro-dynamometer. The article gives complete details regarding the slight alterations which the experimenters had to make in the dynamometer itself. Three trials gave the following E.M.F. for the cells with the thermometer showing at 15 degrees: 1·43355 volts, 1·43333 volts, and 1·43305 volts. After correcting a slight error in the thermometer, the mean reading was assumed to be 1·4333. This result fully agrees with the work with other experimenters, and the authors. Prof. Carhart also took two cells to Berlin, where they were compared with those in the Reichsanstalt, and the result showed that the E.M.F. was found to be only one part in 20,000 higher than the mean of all the normal Clark cells in both departments of the Reichsanstalt. This clearly shows that the Clark cell of the above form is excellently suited for an electrical standard.

Electric Cabs in Berlin.—The performances of the London Electric Cab Company and the Electric Omnibus Company have certainly not rendered electrically propelled vehicles very popular in London; elsewhere, however, there is no cause for any such unpopularity, and the constructors of electric cabs of the self-contained type continue their work successfully, even where such obstacles are to be overcome as in the German capital. Motor-cabs there, except the electro-motors, are almost impossible owing to the police regulations, and the electric cabs also were required to correspond as closely as possible to the horse-cabs at present in use. In the new model, now plying in the streets of Berlin, two electro-motors are fixed beneath the driver's seat, each weighing 110 lbs., and developing 2 h.-p. The voltage of the motors is 85, and the number of revolutions 1,100 per minute. A novelty in these cabs is the use of a flexible power-transmission shaft between the electro-motors and the intermediary shaft. The motors are independent of each other, each being provided with one of these flexible shafts and geared separately, one to each of the rear road wheels, by sprocket wheels and driving chains, thus rendering differential gear unnecessary. By a special device of the controller one motor suffices to drive the cab at reduced speed, in case of a break-down. The motors are rigidly attached to the body of the cab. The flexible shafts are supported at their ends on roller bearings, and are claimed to be more efficient than spur-gear transmission. The battery of accumulators is carried in a box, under the vehicle, which can be removed and replaced by another with fully-charged cells in from two to three minutes. The battery, which has a capacity 60 to 70 ampère-hours, being sufficient for a journey of from 30 to 40 kilometres on one charge, consists of 44 cells of the Horgen type. The controller is manipulated by the driver's left hand, and provision is made for the motors to act as electrical brakes; in addition to these there are band brakes on the rear wheel hubs actuated by a foot pedal. The vehicle is provided with wooden wheels and solid rubber tyres, and weighs complete 2,510 lbs. It offers accommodation for five persons besides the driver, and can attain a maximum speed of 18 kilometres per hour; though the average permitted by the police regulations in the German capital is but from 12 to 14 kilometres.

MARINE ENGINEERING AND SHIPBUILDING.

Shipbuilding in 1899.—The total production in British shipyards has been 1,640,000 tons, which is about the same as in 1898. Of this

about 130,000 tons were warships, 47,000 tons sailing ships, and 110,000 tons steam trawlers, tugs, steam yachts. The rest of the tonnage is about equally divided between cargo steamers and the steamers of the main lines—about 650,000 tons representing less than 100 steamers, while 700,000 tons were for cargo steamers. Seven steamers had a total tonnage of 92,261 tons. The *Oceanic*, the largest vessel yet built, coming first with 17,274 tons. The new industry of oil carriage accounts for 30,000 tons of shipping during the year. Manufacturers of shipbuilding material complain of the workmen taking advantage of the pressure in business, and that the waste of time is as much as 25 per cent. Whatever the cause may be, materials have advanced in price by nearly 20 per cent.; the price of shipplates being now £8 per ton. The government has placed considerable orders with private firms for battleships, cruisers and destroyers. During the year important amalgamations of ship-building and engineering firms have taken place. The Thames Ironworks, Ltd., has taken over the famous old firm of Messrs. John Penn & Sons; and Messrs. John Brown & Co. of Sheffield, have taken over the Clydebank shipbuilding yard of Messrs. J. and G. Thomson. Foreign yards have been also full of orders, and have turned out 680,000 tons against 480,000 tons during the previous year. The United States built 76 steamers of 163,918 tons; Germany 140 steamers of 247,658 tons; France 16 sailing ships of 43,780 tons, and 8 steamers of 16,806 tons; Holland 71 steamers of 41,345 tons; Russia 5 steamers of 30,619 tons, and Italy 12 steamers of 29,101 tons. There has been during the year a considerable sale of British ships by foreign shipowners. Two British lines of coasting steamers have been bought by German shipowners in the East, one consisting of 11 steamers and the other of 14 steamers.

Hatches and Ventilators of Steamers.—A serious statement has been made by Mr. H. T. Wallace, a member of the Liverpool Underwriting Association, with respect to the security of steamers' hatches and ventilators. The report prepared deals with steamers of over 1,500 tons gross, and covers a period of nearly three years from January, 1897, to October 31st, 1899. During this time, 95 cases of accident to hatches or ventilators took place. In four instances, the result was the loss of a steamer, and in numerous others, the cargo had been damaged by the water getting below. At a recent inquiry into the operation of the Atlantic freeboard by the Board of Trade it was stated by a member of a large shipbuilding firm: "That the hatches are the great weak point in ordinary cargo boats, but in vessels constructed on the trunk principle in this respect there is nothing to fear." It was also said at the same inquiry by a master of about nine years' experience in command of tramp steamers: "That he considered a ship weak when the engine-room skylight got smashed by an ordinary sea, and the ports forced in, and the ventilators blown short off the deck. If weak in the vital parts on deck, even though the hull be strong, he considered that a weak ship." There is clearly here room for improvement in the construction of hatches and ventilators.

French Submarine Boat Failures.—Though the *Holland* has been to some extent a success, and great hopes are entertained of the *Plunger*, which is expected shortly to be ready, a recent Paris despatch states that the optimistic accounts which were printed recently regarding the trial of the submarine torpedo-boat *Narval* are discounted by the fact that an order has been issued to cease work on two sister boats until defects in the *Narval* have been remedied. The chief difficulty seems to be in changing the motor-power from steam when the vessel is travelling on the surface to electricity, which is used while she is under water. During the trials it was shown that this change was made slowly and was unsafe.

France has taken to the new submarine boats, has built three, and has nine building.

Parsons' Turbines.—Two destroyers, one for Russia, and the *Viper* for Great Britain, have been fitted with these steam turbines. The displacement is 360 tons, and the indicated horse-power to be developed is 10,000. The latest trial of the *Viper* has shown a speed of 35½ knots, or about 41 miles an hour.

"Pegasus" and "Pyramus."—These cruisers are two of eleven of the third-class which have both been constructed by Palmers Shipbuilding and Iron Co., Ltd., of Jarrow-on-Tyne. The whole of the class have been fitted with express boilers, these last two being of the Reed type. The principal dimensions are 300 ft. between perpendiculars; breadth, 36 ft. 6 in.; depth, 21 ft. 2 in.; displacement, 2,135 tons; i.h.-p., 7,000; the estimated speed being 20 knots. The contract price was £135,000. There are two sets of vertical triple expansion engines, the working pressure of the 8 Reed boilers being 300 lbs., reduced to 250 lbs. at the engines. The cylinder dimensions are $\frac{20\frac{1}{2} \times 33 \times 54}{27}$ and the speed 220 revolutions per minute. The four-hour full-power trial of the *Pegasus* gave the following results:—Average draught, 14 ft. 10 in.; press of steam, 255 lbs.; revolutions, 217·75; vacuum, 25·15; i.h.-p., 7,127; air pressure, 2·44; speed, 21·2 knots.

RAILWAY WORK.

Railway Progress in Japan.—According to a report of the Japanese Railway Bureau the total mileage of the State and private railways in Japan amounts to 3,420 miles. Of this total the State railways include 768 miles, and the private lines 2,652 miles. The total rolling stock of the State

and private lines in March, 1899, included 1,103 locomotives, 3,811 passenger cars, and 14,088 freight cars. The total mileage runs for the year was 24,917,429 miles for locomotives; 22,977,400 miles for trains, and 310,667,984 miles for passenger and freight cars. During the 12 months ending March 31st last a total of 99,061,889 passengers were carried, and freight amounted to 9,916,126 tons, beside 36,705 tons of baggage. The total receipts were £3,118,126. The figures given show a profit of 3·3 per cent. on the cost of constructing the lines open.

Baldwin Locomotives on British Railways.—It is reported that these have a greater coal consumption than British-built locomotives doing the same work, and that the wearing qualities of the engines are not so good. It is obvious, however, that reports of this kind should be accepted with caution. It is worth while noting, in this connection, that a French railway company has given a repeat order to the Baldwin Company.

Progress of the Siberian Railway.—On the 20th December, 1899, the last rails were laid down on the Trans-Baikal section of the Siberian Railway, thus completing for the present the great enterprise began nine years ago, and establishing uninterrupted steam communication between Western Europe, St. Petersburg, and the extreme limits of the Russian Empire on the Pacific coast. The length of this last section just finished is 693 miles, from the eastern shores of Lake Baikal, going through Chita to Stretensk on the river Shilka, a tributary to the Amur. The trains are transported across the Baikal Lake on the ice-breaking ferry-boat built by Sir Wm. Armstrong, Whitworth & Co., and from Stretensk the river route must be used to arrive at Khabarovsk, whence the Uszuri section of the railway runs on to Vladivostock. It is to be remembered, however, that many hundreds of miles have still to be constructed between Saretensk and Khabarovsk before uninterrupted communication between European Russia and Vladivostock becomes an accomplished fact. It is at this gap that the most serious engineering difficulties present themselves, and the work is certain to be slow and costly. In their initial stage Russian Asiatic railways are little better than steam tramways. Everything is sacrificed to speed of construction. When the country is level and not broken by watercourses, that method serves well enough to make a show of quick performance. But it is little more than show. Many years must elapse before the Siberian line can be of much use for the speedy transport of large bodies of troops—its primary purpose.

CHEMICAL.

The Synthetic Production of Alcohol.—It has been known for a considerable period that carbide of calcium is susceptible of conversion into a number of allied products, chief among which are sugar and alcohol. It is stated that a process for the production of the latter is now in successful operation in Russia. The alcohol is absolutely pure, and the cost is stated to be as low as fourpence per gallon. Limestone and coke are heated electrically to form calcium carbide, and this is used to produce acetylene, which is passed through a warmed reducing salt of the protoxide chrome sulphate type, like the double sulphate of chrome and ammonia, by which it is absorbed, giving off hydrogen; in this reaction ethylene gas is produced and the chromium oxide is reduced; the reducing salt is brought back to its former condition by the action of nascent hydrogen produced electrolytically. The ethylene is passed through sulphuric acid, which absorbs it, forming hydrogen-ethyl-sulphate, to which one-third its weight in water is added; this is heated and gives off ethyl alcohol, which is distilled off. To prevent its being used for drinking purposes, a material is added to it which gives it a nauseous taste.

A Substitute for Celluloid.—A Consular report from Freiburg states that a new substance, closely resembling celluloid, has been produced by boiling untanned leather in oil. It has the property of being a good electrical insulator, and can be used for many purposes. This new material, to which the inventor has given the name "marloid," can be polished on both sides, and in its structure resembles horn, and can be pressed or worked into any form whatsoever, either directly after the boiling process or later, after the hardened hide has been made soft and elastic by being dipped into a salt or alum bath. By means of polishing, this material can be made almost transparent, and it can be given different degrees of hardness, so that a substance is obtained which can be kneaded, embossed, stamped, pressed, drawn, and twisted into any desired shape, style, or design.

Continuous Process for Making Calcic Carbide.—It is reported that a process by which calcium carbide can be continuously produced more cheaply than by that at present in use has been discovered by Prof. Freeman, Chicago. A huge arc lamp enclosed in brickwork in the interior of a furnace was employed. The upper electrode of the lamp was hollow, and through it was fed a powder composed of 60 per cent. of common lime and 40 per cent. of coke. This powder, being carried through the upper carbon directly into the electric flame, was melted by the intense heat. All the power of the electric plant of the Institute was turned into the electrodes; and calcium carbide in a molten state ran from the machine. It was estimated that the carbide was produced at a cost of ½ c. per pound.

MISCELLANEOUS.

An Alleged New Illuminating Gas.—It is announced from Springfield, Mass., that Dr. L. E.

Niles and L. L. Norley (who claims to be the inventor of the arc light, the dynamo, and 200 other electrical inventions) have discovered an entirely new gas, of which they can make an illuminant as clear as "daylight." The discoverers say that a dozen of these lights would brightly illuminate New York City, and that the cost per night of running one of the lights of 300,000 candle-power would not be greater than 15 cents.

The Largest Belt Made.—This distinction, which we fancy lately belonged to the Rossendale Belting Company, would appear to have passed to the other side of the Atlantic, where it is said that a Canadian concern has made what is said to be the largest belt yet manufactured. The belt was of rubber, and measured 3,529 ft. in length—over two-thirds of a mile. Its weight was nine tons. This mammoth belt was made for the grain elevator of the Intercolonial Railway at St. John, N.B., and is now in use there. Another immense main-drive belt, 58 ins. wide and 338 ft. long, with a weight of 2½ tons, was recently completed for one of the Canadian Pacific Railway elevators at Fort William by the same Company.

New Roofing Cement.—A new kind of cement roofing has been introduced in Germany by Mr. N. H. Henningsen, a Cologne engineer. It is particularly suitable for the roofing of factories, boiler-houses, smithies, foundries, &c. The preparation consists of a mixture of cement and good sand applied 1¾ in. thick. The most important feature of the roofing is the introduction of bands of iron, of which the purpose is not to support the cement in which they are embedded, but to prevent any air-currents penetrating it, as cement is more susceptible to draught than to pressure. Thus constructed the cement roofing is said to be absolutely impervious, fireproof, and cheaper than all ordinary roofings.

The Purification of Acetylene.—Dr. F. B. Ahrens, of Breslau, has lately investigated the causes which occasionally produce much heating and a large yield of free or combined chlorine when chloride of lime is adopted as an acetylene-purifier. He finds that chloride of lime *alone* does not heat in the gas; the rise in temperature is due to the presence of sawdust and water, which are employed to increase the bulk of the material or its power of absorbing impurities. He concludes that chloride of lime must either be mixed with a large quantity of sawdust or with a very small quantity of water; but it is preferable to omit the sawdust entirely, using in its place kieselguhr (infusorial earth), powdered coke, powdered brick, or chromate of lead, as recommended by Wolff. Incidentally he explains the complaints made by Vertess about the Veszprim acetylene (cf. this column, October 21), for he says the gas was treated with chloride of lime [presumably without a second vessel, charged with slaked lime only], and periodically smelt so strongly of chlorine, and annoyed the consumers so much, that the whole process of purification had to be temporarily abandoned. Yet another investigation of acetylene purifying processes has been carried out by Dr. G. Benz, of Heilbronn. He says that Frank's and Ullmann's materials are very similar in their action, and are both satisfactory, especially in dealing with the phosphoretted hydrogen. Chloride of lime, however, is cheaper and simpler, but it must be used with a second vessel, containing slaked lime alone. In order to prevent overheating, he agrees with Ahrens that sawdust must not be added, powdered slag or coke being better.

Workshop Heating.—Mr. Walter B. Snow, in the course of a recent article in the American press, says:—"When heating is accomplished by direct radiation with steam pipes strung along the walls, the wall itself adjacent to the heating surface is maintained at high temperature, so that the temperature difference between it and the external air is great, and rapid transmission of heat results. With an overhead arrangement of piping the loss is less, but nevertheless of considerable magnitude; air is a very poor absorbent of radiant heat, and is readily warmed only by direct contact with the heating surface. With the low velocities resulting from the natural circulation of air across such surfaces the hourly condensation per square foot of surface with low pressure steam is only about three-tenths of a pound of steam, equivalent to about 1·8 British thermal units per square foot per hour per degree difference between the temperature of the steam and the air. In the ordinary hot blast apparatus, such as is employed in the fan system, the heating surface is massed in one location, a decided contrast to the almost unlimited extent of pipe required when a direct heating system is employed."

Improved Process for the Production of Lime-Carbonic Acid.—In this process limestone and carbonaceous fuel are charged into a kiln, from which all air is practically excluded. Oxygen, obtained by any commercial process, is then supplied to the bottom of the kiln. The gases, consisting mostly of carbon monoxide, are drawn off at a point above the charge of incandescent fuel and limestone, into a combustion chamber, in which enough additional oxygen is supplied to convert the carbon monoxide into dioxide. The heat thus generated is used to raise steam for the compressor employed to liquefy the carbonic acid gas so produced.

The Balloon as a War Machine

Will be the title of an interesting article, from the pen of Mr. H. Lawrence Swinburn, that will appear in the March number.

Depreciation—

Until now a subject never thoroughly investigated—will be dealt with by Prof. R. H. Smith.

ARCHITECTURE AND DESIGN.

1. Construction and Design.

Arch Construction.—*A new form of Hollow Tile Fireproof Floor Arch Construction.* Description of a serrated arch invented by Henry L. Hinton. 1 col.—*Engng. News*, Nov. 9th, 1899.

Baths.—*The Sutro Baths, San Francisco.* Account of a large bathing establishment on a terrace cut out of a cliff. 1 col.—*Engng. Rec.*, Nov. 11th, 1899.

Circular Stairs.—*The Construction of Circular Stairs and Spiral Vaults.* By Lawrence Harvey. Describes the history of this form and gives some indications of the construction. 1½ cols.—*Brit. Arch.*, Nov. 3rd, 1899.

Framing.—*An Unusual Framed Building.* Account of a building with sides and roof supported by a single truss system. ¼ col.—*Engng. Rev.*, Nov. 18th, 1899.

Hall.—*The Convention Hall at Kansas City, Mo., U.S.A.* Description of hall having a seating capacity of 25,000 persons. 1½ col.—*Engng. News*, Nov. 2nd, 1899.

Library.—*The Washington Public Library.* Description of the arrangement of the Carnegie Library. 1½ cols.—*Engng. Recd.*, Nov. 11, 1899.

New Church Building.—*The New Parish Church of St. Anthony in the Tenth District, at Vienna.* For the densely populated district numbering 90,000 Catholic inhabitants, heretofore only one church, with a capacity of 2,000 persons, existed, which induced Archbishop Dr. Anthony Grusha to devote the sum of 100,000 florins to the building of a new church in Venetian style, erected after the plans of Architect Franz R. v. Neumann. 3¼ cols.—*Ztschr. d. Oest. Ing. u. Archit. Ver.*, Jan. 5th, 1900.

New York Capitol.—*The New York Capitol Building.* By Cuyler Reynolds. Short history of this building, for which nearly 30,000,000 dollars have already been sacrificed. 4 cols.—*Arch. Rev.*, Dec., 1899.

Steel Cage.—*Wall Supports in a Steel Cage Building.* Account of the peculiar steel-cage details in building for offices and light manufacturing, having a height of 16 stories. 1 col.—*Eng. Recd.*, Nov. 4th, 1899.

Stone.—*Stone in American Architecture.* Discussion of the employment of various stones as a building material, stone-working, etc. 8 cols.—*Arch. Rev.*, Oct.-Dec., 1899.

Trusses.—*Pin and Riveted Roof Trusses.* Article discussing the relative merits of both systems. ⅛ col.—*Engng. Recd.*, Nov. 11th, 1899.

2. Heating and Ventilation.

Heating.—*A Hot-Blast Gravity Steam Heating Apparatus.* Description of heating apparatus in a Utica bank building. (Ill.). 1 col.—*Eng. Recd.*, Nov. 7th, 1899.

Heating.—*Ventilation in its Relation to Heating, etc.* By W. R. Maguire. Abstract of paper read before the Brit. Inst. of Heat. and Vent. Engrs. 4½ cols.—*Plumb. and Dec.*, Nov. 1st, 1899.

Heating Surface.—*Heating surface: Its best Form and Relation to radiating surface.* John Kitchen. Abstract of paper read before the Brit. Inst. of Heat. and Vent. Engrs. Account of the various systems and methods. 3 cols.—*Plumb. and Dec.*, Nov. 1st, 1899.

Sanitation.—*Sanitation of Establishments used for Colour Printing.* J. Carlioz. Method of dust removal by ventilating fans. 1½ cols.—*Génie Civil*, Nov. 4th, 1899.

Ventilation.—*Screw Fans.* Abstract from a paper by Chas. H. Innes, read before the North-east Coast Institution of Engineers and Shipbuilders, Dec. 14th, 1899, in which the author deals with screw or axial-flow fans which, when space is limited, are preferable to the more efficient centrifugal fans. (Ill.). 1½ cols.—*Mech. Engr.*, Dec. 23rd, 1899.

Ventilation and Heating.—*Ventilation and Heating of a large New York Residence.* Detailed description of an interesting ventilating and heating plant, distinguished by completeness and a studied use of limited space, installed during the present year in the residence of Mr. W. D. Sloane, on the corner of Fifth Avenue and West Fifty-second Street, in New York city. (Ill.). 5 cols.—*Engng. Rec.*, Dec. 23rd, 1899.

Ventilation and Heating.—*Ventilation and Heating of the new Boston Terminal Station.* Abstract from an interesting official statement presented to the American Society of Mechanical Engineers by Mr. Walter C. Kerr, of Westinghouse, Church, Kerr & Co., the engineers of the entire mechanical equipment of the station. (Ill.). 4 cols.—*Engng. Recd.*, Dec. 9th, 1899.

3. Plumbing and Gasfitting.

Gas Fittings.—*Sound Gas Fittings.* By Martin H. Humphreys. The necessity of providing for tight gas fittings. 2 cols.—*Jour. Gas Lght.*, Nov. 7th, 1899.

4. Miscellaneous.

Architectural Practice.—*English and American Architectural Practice.* By R. Clipston Sturgis. The author compares the difference of practice in the two countries. 4 cols.—*Arch. Rev.*, Nov. 1899.

Architecture.—*Presidential Address before the Royal Inst. of British Architects.* By William Emerson. Summary review of architecture and architects of the past century. 8 cols.—*Builder*, Nov. 11th, 1899.

Brasses.—*Monumental Brasses.* By G. H. Smith. Abstract of a paper read before the British Arch. Association, giving an outline of the development of brasses. 2 cols.—*Builder*, Nov. 11th, 1899.

Bricklaying.—*Practical Bricklaying.* By Owen B. Maginnis. Description of the tools and appliances used by the bricklayer. 1 col.—*Arch. and Build.*, Nov. 1899.

Stained Glass.—*Domestic Stained Glass in France.* By René de Cuers. Account of the present state of stained glass window manufacture, notably for domestic use. (Ill.). 5 cols.—*Arch. Recd.*, Oct.-Dec. 1899.

CIVIL ENGINEERING.

1. Bridges.

Arches.—*The Statical Investigation of Arches.* By M. Marcus. A graphical analysis of the statical reactions in voussoir arches. 1 col.—*Schweiz. Bauztng.*, Oct. 21st, 1899.

Bridesbury Bridge.—*The Delaware River Bridge at Bridesbury.* Article describing the details of a steel bridge with both plate girders and large truss spans. 2½ cols.—*Eng. Recd.*, Nov. 25th, 1899.

Bridge Construction.—*The American Bridge.* The author points out that while it would be difficult in any European country to tell in what part of the continent any bridge has been constructed, the American type, a pin connected truss bridge, would at once be recognised by its peculiar proportions. It is in the design of the longest bridges, of 1,500 ft. span and over, that America has made its most important contribution to the art of bridge building. 1¼ cols.—*Sc. Am.*, Dec. 23rd, 1899.

Bridges.—*Some New French Bridges.* By Frahm, Railway Building Inspector. (Conclusion.) The article describes in detail the new Alexander Bridge at Paris, the Viaud Viaduct of the Carmaux-Rodez Railway, and a bridge across the Seine of the Western Railway. 18 cols.—*Stahl u. Eisen*, Dec. 15th, 1899.

—— *The New Cornwall Bridge Piers.* This article gives a detailed description of a single-track bridge across the St. Lawrence River at Cornwall, Ontario. The new bridge is the most important structure on the line of the New York and Ottawa Railroad. (Ill.). 8¾ cols.—*Engng. Rec.*, Dec. 9th, 1899.

—— *American Bridges in Japan.* Article describing two bridges shipped to Japan last year by the China and Japan Trading Company, one for railway service and the other a highway structure. (Ill.). 2 cols.—*Engng. Recd.*, Dec. 23rd, 1899.

East River Bridge.—*The Cables and Suspenders for the New East River Bridge, New York City.* Description of the centre suspension span. 2½ cols.—*Engng. News*, Nov. 23rd, 1899.

—— *The New East River Bridge.* Article containing specifications for the steel cables, suspenders, coverings, sheaves, bands, etc. (Ill.). 2 cols.—*Ir. Age*, Nov. 16th, 1899,

Highway Bridge.—*Redecking a Viaduct.* Description of the method of renewing a highway bridge floor. ½ col.—*Engng. Recd.*, Nov. 11th, 1899.

—— *Widening a Washington Highway Bridge.* Description of a method of adding cantilever brackets for side-walks, to a plate-girder skew bridge. ½ col.—*Engng. Recd.*, Nov. 11th, 1899.

—— *The Snake River Bridge.* Account of a cantilever highway bridge provided with rocker bents under the cantilevers and inclined anchor-arms. 2 cols.—*Eng. Recd.*, Nov. 18th, 1899.

Hudson Bridge.—*New York Central Improvements at Albany.* Description of the re-construction of the Hudson River passenger bridge. 1 col.—*R. R. Gas.*, Nov. 10th, 1899.

Lattice Girders. — *The centring of diagonal members in Parallel Lattice Girders.* By L. Nicolaz. An investigation for the purpose of ascertaining the most advantageous positions for diagonal members in lattice girders. 1 col.—*Schweiz. Bauztng.*, Oct. 28th, 1889.

Trans-shipping Bridge.—*The New Bridge at Rouen.* Translation of an article in *La Nature*, giving a description of a trans-shipping bridge. ½ col.—*Scient. Am.*, Dec. 2nd, 1899.

2. Canals, Rivers and Harbours.

Bar.—*The Bar at Rio Grande do Sul.* L. Vauthier. Description of a method for the maintenance of a permanent channel at the mouth of the canal connecting the Port of San Pedro, Brazil, with the ocean. 7 cols.—*Ann. des Ponts et Chaussées*, 2 Trimestre, 1899.

Dams.—*Proposed Design for a Steel and Concrete Dam.* By John S. Fielding. The author describes the advantages of a truss-design. 2 cols.—*Engng. News*, Nov. 16th, 1899.

Drainage.—*Drainage of the Swamps in Polesia.* Article, accompanied by a complete map, describing the canalization of the district and the contemplated improvements. 2 cols.—*Oest. Monatschr. f. d. Oeffent-Baudienst*, Nov. 1899.

Canals.—*The Dortmund-Ems Canal.* Short outline of this interesting waterway. (Ill.). 1 col.—*Engr.*, Nov. 17th, 1899,

Dredging.—*Steam Tenders for Dredges on the Mississippi River.* The article, accompanied by a two-page plate, describes five large steam tenders now under construction by the Mississippi River Commission, and to be used to handle the large modern dredges employed in maintaining the navigable channel of the river. 2½ cols.—*Engng. News* (New York), Dec. 7th, 1899.

—— *Hydraulic Dredger (Bates System) for the Russian Government.* Description of a hydraulic dredge, built on the Lincoln W. Bates' system by the Société John Cockerille at their Liège works, for the Russian Government for use on the Volga River. The article is accompanied by a two-page plate and other drawings. (To be continued.) 3½ cols.—*Engng.*, Dec. 15th, 1899.

—— *Hydraulic Dredger (Bates System) for the Russian Government.* (Conclusion.) (Ill.). 7 cols.—*Engng.*, Dec. 29th, 1899.

Harbours.—*Harbour Works at Otaru, Japan.* By Imperial Edict of July 8th last, Otaru has become one of the open ports of Japan. Situated on the west coast of the Island of Yesso, now generally known as Hokkaido, the most northern of the four great islands of which Japan proper is composed, it has been the *entrepôt* of nearly one half of the produce of the whole island. Owing, however, to its imperfectly sheltered condition there is often a heavy sea inside the harbour. The Government have now undertaken to transform the open road into a closed harbour. (Ill.). 3½ cols.—*Engng.*, Dec. 14th, 1899.

Harbours.—*The Harbour at Cosel on the Oder and its present Commerce.* By J. Riedel. Description of the considerable internal commerce at Cosel, near Breslau. 2 cols.—*Zeitschr. d. Oest. Ing. und Arch. Ver.*, Nov. 10th, 1899.

Landing Pier.—*Landing Pier at Pauillac.* By Ch. Talansier. Description of a new pier on the Gironde, forming a deep-sea port for the city of Bordeaux. (To be continued.) 2 cols.—*Génie Civil*, Nov. 4th, 1899.

River Engineering.—*The Utilisation of the Nile.* Among the improvements being carried on in Egypt at the present time is the construction of large irrigation works, in order to render 2,500 square miles productive. These works include a large dam on the Nile at Assuan, and a smaller dam or barrage at Assiut. The article gives data of these works, and a general description of the enterprise. 1¾ cols.—*Engng. Recd.*, Dec. 30th, 1899.

River Regulation.—*The Regulation and Information Service on the Rhine.* Outline of the methods employed for regulating the Upper Rhine, and of the telephone since established for communicating warnings of sudden freshets. 3 cols.—*Oester. Monatschr. f. d. Oefferte-Baudienst.*, Nov. 1899.

River Regulation.—*Rock Dams with Metallic Reinforcement.* By A. Dumas. Description of interesting reservoir-dams in California, constructed with sheet-iron core and stone embankment. 3 cols. —*Génie Civil*, Oct. 1899.

Ship Canal.—*The 3,000-ton Concrete Blocks and Rolling Caissons at the Bruges Ship Canal, Belgium.* Abstract of a paper by L. V. Vernon Harcourt, read before the Inst. of Civ. Engrs. The author describes the method of manufacturing these artificial monoliths. 1¾ cols.—*Engng. News*, Nov. 1899.

—— *The Transformation of the Lateral Canal of the Loire.* M. Mazoyer. Description of the works, with outline of the aqueducts, bridges, and other details. (Ill.). 12 cols.—*Ann. des Ponts et Chaussées*, 2 Trimestre, 1899.

3. Irrigation.

4. Miscellaneous.

Cement.—*The Works of the Nazareth Portland Cement Company.* Article describing cement-works at Novgarett, Pa., U.S.A., which contain several features of special interest. (Ill.). 4½ cols. —*Engng. Recd.* (New York), Dec. 16th, 1899.

Cement.—*Tests of Cement and Concrete.* By Josef Schusteer. Account of experiments made in the laboratory of Robert Wünsch at Budapest, with carefully compiled data concerning the various specimens tested. 4 cols.—*Zeitschr. d. Oester. Ing. u. Arch. Ver.*, Oct. 20th and 27th, 1899.

Nile.—*The Engineering Control of the Nile.* Account of the means adopted and under contemplation for the control of the Nile. (To be continued.) 3 vols.—*Builder*, Oct. 21st, 1899.

—— *Utilisation of the Nile.* An account of definitely adopted scheme of a dam at Assouan and a barrage at Assiout. 1½ cols.—*Engr.*, Nov. 3rd, 1899.

Scour.—*Dangerous Scour caused by Bridge Piers.* Account of the effect of piers in the Gatineau River, Canada. ½ col.—*Engng. Recd.*, Nov. 11th, 1899.

Water Supply.—*The Water Supply Question in Bavaria.* The article deals with the subject in general, and especially refers to the water-bearing strata beneath Munich. 2½ cols.—*Zeitschr. d. Ver. Deutschr. Ing.*, Nov. 7th, 1899.

—— *A Lesson in Water Works Management.* Account of the economical method with which the New York waterworks were managed whenever the commissioner had sufficient technical knowledge to understand engineering reports, and the waste which occurred whenever such was not the case.—*Engng. Recd.*, Nov. 11th, 1899.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Acetylene.—*The Cost of Producing Carbide by Different Agencies.* Abstract in English of a paper by Mr. F. Liebetanz, of Dusseldorf, read before the recent Acetylene Congress at Buda-Pesth and printed in the "Zeitschrift für Elektrochemie." 3¼ cols.—*Journ. of Gas Lighting*, Dec. 26th, 1899.

—— *The Cost of Calcium Carbide.* The author points out that in Great Britain the acetylene industry is somewhat unduly handicapped in its efforts to make headway by the exorbitant price demanded for calcium carbide, which, including the charges for carriage, etc., is scarcely to be procured in English villages and rural districts some distance from a railway station at less than 26*s.* or 28*s.* per cwt. 4½ cols.—*Engr.*, Dec. 22nd, 1899.

Acetylene.—*Acetylene Gas considered commercially.* By Horace Allen, C.E. The article contains data for the calculation of the cost of production of acetylene gas under the circumstances prevailing at present. 2½ cols.—*El. Rev.*, Jan. 5th, 1900.

Electro-Chemical Laboratory.—*Installation of high tension currents in the Electro-chemical Laboratory of the Polytechnical School at Zürich.* There are facilities for procuring alternating currents of 12·5, 25, 37·5 or 50 volts and continuous currents of 75 volts. 1 col.—*Schweiz. Bauztg.*, Nov. 11th, 1899.

Electrolysis.—*Electrolytic Processes in Industrial Operations.* By Dr. W. Borchers. Summary of the great progress in electro-chemical manufacturing, giving full description of several forms of apparatus. The author dwells on the fact that formerly wasted water-power is being usefully employed in this industry. 14 cols.—*Engng. Mag.*, Dec. 1899.

—— *The Electrolytic Treatment of Complex Sulphide Ores.* By Sherard Cowper-Coles. Account of various electro-metallurgic processes, notably wet extractive processes. (To be continued.) 3 cols.—*Electrician*, Nov. 10th, 1899.

—— *Electrolysis of Cast Iron Water-Mains.* By Prof. Lucien J. Blake. The effects of electrolysis from railways are generally considered as limited to those points where currents are leaving underground metallic structures. Recent observations and experiments, however, have shown to the author that effects of electrolysis upon water-mains are not limited to the above determined danger-areas, and he describes the effect of electrolysis upon water-mains. 2½ cols.—*Elec. World and Engr.*, Dec. 16th, 1899.

Electro-Metallurgy.—*The Electro-Chemical and Electro-Metallurgical Industries in* 1899. By John B. C. Kershaw. Interesting summary of the electro-chemical enterprise during the past year.—*Elec. Rev.*, Jan. 5th, 1900.

—— *The Electro-Chemical and Electro-Metallurgical Industries in* 1899. By John B. C. Kershaw. (Continuation.) The article continues the interesting summary by the author of the electro-chemical enterprise during the past year. 3 cols. —*Elec. Rev.*, Jan. 12, 1900.

—— *The Ozonization of Water.* By E. Andréoli. Account of the oxidizing effect of ozone upon organic matter contained in water. 1½ cols.—*L'Electricien*, Nov. 4th, 1899.

Ozone.—*Ozone and its Technical Uses.* Outline of the discovery and history of ozone, and description of its modern applications in bleaching, sterilization, etc. Two articles. — *Die Elektricität*, Oct. 28th and Nov. 11th, 1899.

2. Electric Lighting.

Electric Lighting.—*The Design and Construction of a Modern Central Lighting Station.* By H. H. Humphrey. Abstract of a paper read before the Engineers' Club of St. Louis, giving a detailed description of the electric lighting station in that city, erected by the Imperial Electric, Light, Heat, and Power Company. (Ill.). 4½ cols. (To be continued.)—*Mech. Engr.*, Dec. 30th, 1899.

—— *The Design and Construction of a Modern Central Lighting Station.* By H. H. Humphrey. (Conclusion.) The article deals with the Central Plant for Lighting in the city of St. Louis, Mo., U.S.A. (Ill.). 7¼ cols.—*Mech. Engr.*, Jan. 6th, 1900.

—— *The Design and Construction of a Central Lighting Station.*—Abstract of a paper by Mr. H. H. Humphrey, read before the Engineers' Club of St. Louis, Mo., U.S.A., giving an interesting description of a modern plant erected by the Imperial Electric, Light, Heat and Power Company in that city. (Ill.). 11 cols.—*Engng. Recd.*, Dec. 9th, 1899.

Electric Lighting.—*Electric Lighting at the Hotel Metropole, Chicago.* The article deals with a very interesting electrical equipment of an American hotel, supplied by the Westinghouse Electric and Manufacturing Company. (Ill.). 2 cols.—*Elec. Engr.*, Dec. 29th, 1899.

—— *Large Electric Light Engines.* By R. D. Summerfield. The author describes various engines of over 500 h.p., but more especially of 2,000 h.p. or more, many of which are being built in England, America, and on the Continent. 4 cols. —*Elec. Engr.*, Jan. 5th, 1900.

Electric Plant.—*Electrical Plant at the Blackpool Winter Gardens.* Description of the illustration and its working. (Ill.). 2¾ cols.—*Electricity*, Dec. 22nd, 1899.

—— *Warsaw, Poland, Central Station Plant.* Comments on report of Mr. W. H. Lindley, who was charged with the investigation of every detail. Discussion of the advantages and disadvantages of direct and alternating currents. 4 cols.—*Elec. Wld. and Engr.*, Nov 4th, 1899.

Incandescent Lamps.—*The advantages of Long Filaments in Incandescent Lamps.* Account of the effect on high resistances, and comments on the material used for filaments. 3 cols.—*Am. Electn.*, Nov. 1899.

—— *The Photometry of Incandescent Lamps.* By Arthur J. Rowland. Description of a plan for readily obtaining results, and of the apparatus employed. (Ill.). 4 cols.—*Journ. Frankl. Inst.*, Nov. 1899.

Transformer.—*A New Type of Transformer.* C. P. Feldman. Description of the new transformer of the Helios Company, being distinguished by a simplified method of winding. 1½ cols.—*Elektrotechn. Zeitschrft.*, Nov. 2nd, 1899.

Underground Wires.—*Underground Conduits for Electrical Conductors.* By C. H. Sewall. Outline of a history of underground construction and description of various types of conduit. 2 cols — *Elec. Engng. and Tel. Mag.*, Nov. 1899.

3. Power.

Accumulators. — *Computation for Equalizing Accumulators.* By C. Bradt. Examination of the method of computing the size of accumulators for equalizing the load in a traction power-house, based upon the experiments of Siemens-Halske. 5 cols.—*Elektrotechn. Ztschrft.*, Oct. 9th, 1899.

—— *The Majert Accumulator.* By A. Wilke. Description of details in the manufacturing of the lead plates and of the special machinery employed for forming the cellular surface, together with an account of the capacity of the storage battery. 5 cols.—*Elektrotechn. Ztschrft.*, Nov. 9th, 1899.

Conductors.— *The Computation of Singly-fed Electric Conductors.* By A. Hecker. Formulas for the computation of the most advantageous cross-section. 6 cols.—*Ztschrft. f. Elektrotechnik.* Two articles, Oct. 13th and Nov. 1st, 1899.

Direct Current Dynamos.—*Recent Papers on the Commutation of the Direct Current Dynamo.* Summary of a number of articles that have appeared in various English and German technical periodicals on the subject. (To be continued.) 5 cols.—*Elec. Rev.*, Jan. 12th, 1900.

Electric Coal Cutter.—*The Jeffrey Thin Vein Coal Cutter.* Heretofore the difficulty and expense of working thin veins of coal have been so great that in various places mining in thin veins has been entirely abandoned. Recently, however, the Jeffrey Manufacturing Company, of Columbus, Ohio, designed a machine which is known as their 16A thin vein coal cutter. After a period of experimental work, it was placed on the market and has since fully demonstrated its ability to perform the work in a satisfactory manner. The article describes in detail this new invention. (Ill.). 1 col.—*Engng. and Min. Journ.*, Dec. 30th, 1899.

Electric Cranes.—*Electric Travelling Crane of 35 Tons Capacity.* Description of a powerful 3-motor crane of 16 metres span. (Ill.). 1½ cols.—*Génie Civil*, Oct. 21st, 1899.

—— *Electric Cranes.* The article describes both movable and stationary cranes operated by electricity. 3 cols.—*Elec. Rev.* (London), Nov. 17th, 1899.

Electric Energy.—*The Cost of Steam and Electric Energy.* Leading article summarizing the contents of two papers read before the Institution of Electrical Engineers: one by Mr. John Holliday, entitled "The Cost of Steam Raising," the other by Mr. R. E. Crompton, on the "Influence of Cheap Fuels on the Cost of Electrical Energy," and the discussion of these papers. 6 cols.—*Engng.*, Dec. 13th, 1899.

—— *The Mount Whitney Power Company.* Description of an electric plant constructed by the Westinghouse Electric and Manufacturing Company in California for the purpose of irrigating the San Joaquin Valley, and furnishing light and power to various small towns. The power is furnished by the Kaweah River and transported to sub-stations 30 and 40 miles distant. 5¾ cols.—*Electr. Rev.* (New York), Dec. 20th, 1899.

Electric Power Plant.—*Switzerland.* The article deals with the power-plant of Schaffhausen, where the famous Rhine falls are used as motive power. (Ill.). 4½ cols.—*Elec. Engr.*, Jan. 5th, 1900.

—— *Electric Power Plant in the Chicago Great Western Railway Shops.* B. T. E. Stuart. At Oelwein, Ia., U.S.A., are located the extensive new repair shops of the Chicago Great Western Ry., which are furnished with a very extensive electric plant, which the author describes in outline. (Ill.). 5 cols.—*West. Electr.*, Dec. 9th, 1899.

—— *The Largest Power-house yet built.* The article describes the gigantic plant of the Third Avenue Railway Company now in course of construction at New York, which is intended to furnish the motive power for the transport of 48,000 passengers at any given moment, outside of the immense weight of the rolling stock. It will be in operation about a year from date. 2½ cols.—*Electricity* (New York), Dec. 20th, 1899.

—— *Examples of European Engineering.* Description of power plants at Rheinfelden, Nuremberg, Plymouth, Hull, and Carlisle. (Ill.). 3½ cols.—*Power* (New York), Dec., 1899.

—— *The Milan Electric Power and Lighting Works.* The tramway system of the city of Milan has, under the auspices of the Edison Electric Company, been completely re-arranged, the cars being now worked by current brought from a hydraulic power station, at Paderno, on the Adda, about 20 miles above the city, by overhead conductors at the very high tension of 13,000 volts. The article describes in detail the installation, the hydraulic turbines, etc. 2 cols.—*Engr.*, Dec. 22nd, 1899.

—— *Imperial Central-station Plant in St. Louis.* An ordinance passed by the Municipal Assembly of the City of St. Louis, Mo., U.S.A., in the autumn of 1896, threw open the doors to all applicants for underground conduit rights. Among the latter was the Imperial Electric Light, Heat, and Power Company, which first turned current into its underground system, October 15th, 1898, which has been in continuous and successful operation since that date. The article describes the design and construction of this plant, which embodies various interesting features. (Ill.). 7½ cols. — *West. Electr.*, Dec. 11th, 1899.

—— *San Gabriel Electric Company.* The article describes the installation of the San Gabriel Electric Company, with its central station at Azusa, California, transmitting electric current to

the City of Los Angeles; one of the most interesting long distance transmission plants that has yet been constructed. The San Gabriel plant in many respects resembles the Hartford, Conn., installation, both of which were supplied by the Westinghouse Electric Manufacturing Company. But while the Hartford plant utilises a storage battery to equalise the load factor, the San Gabriel system gives or takes 500 volts direct current from the power circuits of the Los Angeles Railway Company. The load factor is thus provided for, and a reserve of large capacity is afforded. 3 cols. —*Engng.*, Dec. 22nd, 1899.

Electric Power.—*Examples of Electric Driving.* The article describes the large electric power-plant recently installed for the Berlin Bleaching, Dyeing, and Printing Company, at Oberspree, by the Allgemeine Elektricitäts - Gesellschaft, Berlin. (Ill.). 2 cols.—*Mech. World*, Dec. 29th, 1899.

Electric Pumping.—*Electric Pumping Machinery.* Description of a mine-sinking pump for pumping salt water constructed by the British Thomson-Houston Company, Ltd. This pump has a capacity of 50 gallons per minute against a total head of 70 ft., consisting of 20 ft. suction and 50 ft. lift. (Ill.). ⅔ col.—*Coll. Guard.*, Jan. 12th, 1900.

Kerosene Engine.—*A Kerosene Engine with Direct connected Electric Generator.* The article describes a Mietz and Weiss oil-engine of the latest type, which makes 400 revolutions per minute, developing 4 horse-power, and which is directly connected to a generator, standing upon the same base, supplying current for forty 16 candle-power incandescent lamps. (Ill.). 1½ cols.—*Am. Mach.*, Dec. 21st, 1899.

Measuring Apparatus.—*The Nalder Portable Apparatus for Measuring Feeble Resistances.* M. Aliamet. Account of an improvement over the Wheatstone Bridge, which avoids the errors due to the resistance of contact. 1½ cols.—*L'Electrician*, Oct. 28th, 1899.

Milling Machine.—*Boring and Milling Machine Electrically Driven.* Description of a large and practical tool illustrating the adaptability of electric power to machine tool driving. 1¾ cols.—*Ztschrft. d. Ver. Deutscher Ing.*, Oct. 7th, 1899.

—— *Slippage Meter.* By R. Seeman. Describing an apparatus constructed by Siemens and Halske, consisting of separate counters on generator and motor, with device for simultaneous starting and stopping. 4 cols. —*Elektrotechn. Ztschrft.*, Nov. 2nd, 1899.

Parallel Connection.—*The Parallel Connection of Alternators driven by Gas Engines.* By G. Dettmar. Method of synchronizing the alternators by the use of a magnetic brake acting on the fly-wheel of the gas engine. 3 cols.—*Elektrotechn. Ztschrft.*, Oct. 19, 1899.

Power-Transmission. — *An unusual method of Transmitting Power.* "The city of Columbus, Ohio, U.S.A., operates its own water-works, and also does its own street lighting. Recently three arc machines of 100-light capacity each were installed in the building containing the pumping plant, and the novel plan has been adopted of driving these dynamos by impulse water-wheels supplied with water from the main. As a direct pressure system of water supply is in use, the power to drive the dynamos is really furnished by the pumping engine." The article enters into an enquiry regarding the cost of this method of operating as compared with the ordinary method of driving the dynamos by a compound engine. (Ill.). 1½ cols.—*Engng. News*, Dec. 28th, 1899.

Regulators.—*Elements of Design Favourable to Speed Regulation in Plants Driven by Water Power.* By Allan V. Garratt. Outline of those peculiarities of design that have a direct bearing on speed regulation. 20 cols.—*Trans. Am. Inst. of Elec. Engrs.*, Aug. and Sept. 1899.

Sparking.—*A discussion of Sparking in the continuous current Dynamo.* By Heinrich Isler. Account of the question mainly, with reference to the recent theories of Dr. Fischer-Hinnen. 7 cols. —*Elektrotechn. Ztschrft.*, Oct. 12th, 1899.

4. Telegraphy and Telephony.

Telephone Plant.—*The New Common Battery Bell Telephone Exchange, Brooklyn, N.Y.* The article describes the successful installation of its new central office, "Main," in Brooklyn, by the New York and New Jersey Telephone Company. (Ill.). 3 cols.—*Elec. World & Engr.* (New York), Dec. 23rd, 1899.

Telephones.—*The Copenhagen "Automatic" Telephone Call-Boxes.* The article is taken from the London *Electrician*, and describes the "penny-in-the-slot" system telephone erected in 1898 in Copenhagen. These telephones are placed in nearly all public buildings, theatres, &c., and the experience of over a year has shown that they are thoroughly reliable. (Ill.). 2 cols.—*Electricity* (New York), Dec. 20th, 1899.

Wireless Telegraphy.—*Experiments in Wireless Telegraphy between Chamounix and the Summit of Mont Blanc.* By Messrs. J. & L. Lecarme. This is a communication addressed to the French Academy describing the successful experiments. 1 col.—*Comptes Rendus*, Oct. 1899.

—— By William Baxter, Junr. Account of the principles underlying the system of telegraphy used by Marconi in reporting the recent yacht races. (Ill.). 2½ cols.—*Mach.* (New York), Nov. 1899.

5. Miscellaneous.

Alternators.—*Operating Alternators in Parallel.* The article describes the requirements necessary to such operation and the usual methods employed. (Ill.). 3½ cols.—*Power* (New York), Dec. 1899.

Aluminium.—*Aluminium: its uses and treatment in Electrical Engineering.* Abstract of paper read before the Manchester Junior Electrical Engineers' Society by Mr. J. H. Henderson. The paper gives a short outline of the extraction of aluminium from the substances containing it, its peculiarities as an electrical conductor and its uses. 2 cols.—*Mech. Engr.*, Dec. 30th, 1899.

Circuit Breakers.—*Electrical Circuit Breakers II.* By Wm. Baxter, Junr. The author describes the "Victor" circuit breaker manufactured by G. La Roach & Co., of New York. (Ill.). 2¾ cols.—*Am. Mach.*, Dec. 7th, 1899.

Determination of Speed.—*Stroboscopic Methods of Determining the revolutions and slip of small motors and the Frequency of Alternating Currents.* Summary of a contribution by Dr. G. Benischke to the *Elektrotechnische Zeitschrift*, describing an ingenious device for determining by optical methods the speed of small motors. (Ill.). 1½ cols.—*Elec. Rev.*, Jan. 5th, 1900.

Dynamo Brushes.—*The Electrical and Mechanical Resistance of Dynamo Brushes.* During the past year an experimental investigation was undertaken in the electrical laboratory of Columbia University. The article describes the experiments and summarises the results. 3½ cols.—*Electricity*, Jan. 5th, 1900.

Electrical Engineering.—*The Position of Electrical Engineering.* Editorial criticising the inaugural address of Prof. Silvanus Thompson, mainly as regards the Professor's view that continuous-current machinery is doomed, from which the author entirely differs. 4½ cols.—*Mech. Engr.*, Jan. 6th, 1900.

Electrical Measuring Instruments.—*Stanley Hot-wire Meters and Light Transformers.* Electrical measuring instruments operated by the expansion of a length of wire due to the passage of the current, have been in use in laboratories for many years; but they are too delicate for regular commercial work. A modified instrument, therefore,

has been constructed by Messrs. Hartman and Braun, Francfort-on-Main, Germany. The Stanley Electric Manufacturing Company has secured the sole right for the United States; and the article describes the construction and working of the new apparatus. 1½ cols.—*West. Electr.*, Dec. 16th, 1899.

Electric Power.—*Electric Welding.* By R. F. Danforth. The article describes two well-known methods of electric welding. 2 cols.—*Mech. World*, Dec. 29th, 1899.

Electrical Resistance.—*The Electrical Resistance of Copper.* Report of a committee elected to determine a standard. The article gives the standards determined, and recommends their adoption throughout Great Britain. 1½ cols.—*Engng.*, Dec. 22nd, 1899.

Fire Risks.—*The Protection of Secondary Currents from Fire Risks.* Cary T. Hutchinson. The author draws attention to the dangers existing, and the usual means of protection. He is in favour of the grounding of secondaries. 8 cols.—*Trans. Am. Inst. of Elec. Engrs.*, Aug. and Sept. 1899.

Generators.—*The Apparatus for the Commercial Generation of Oxygen and Hydrogen by the Electrical Current.* W. S. Franklin. Detailed description of the apparatus. 1 col.—*Am. Elect'n.*, Nov. 1899.

—— *Double Voltage and Current Generators.* By Alton D. Adams. Account of advantages of generators that are able to deliver their output as either direct or alternating current. 2 cols.—*Elec. Wld. and Engr.*, Nov. 11th, 1899.

Interrupter.—*A New Universal Mercury Interrupter.* By Dr. Max Levy. Description of an apparatus in which a toothed crown-wheel is rapidly rotated by an electric motor, and a jet of mercury thrown against the teeth. 4 cols.—*Elektrotechn. Zeitschrft.*, Nov. 9th, 1899.

—— *The Mechanism of the Wehnelt Interrupter.* Account of the experiments of Voller and Walter, explaining the various processes to which the action is due. 3 cols.—*Elec. Rev.*, Oct. 20th, 1899.

Lines of Force.—*Distribution of the Lines of Force in Grooved Armatures.* By Dr. F. Niethammer. Mathematical investigation, accompanied by diagrams, to assist in the determination of the ampère windings. 8 cols.—*Elektrotechn. Ztschrft.*, Nov. 2nd, 1899.

Ohm's Law.—*Ohm's Law according to the Vibration Theory.* By Rudolph Mewes. Examination of the vibration theory of resistance as compared with the observed facts, demonstrating that Ohm's Law agrees with the equations for mechanical work. 3 cols.—*Elektrotechn. Ztschrft.*, Nov. 1899.

Phase.—*Means for Producing Great Differences in Phase.* By J. Görner. Account of several methods for the purpose applicable in practice, illustrating the application in the Hartman and Braun meter. 5 cols.—*Elektrotechn. Ztschrft.*, Oct. 26th, 1899.

Radiography.—*Radiograph Tube with Cool Anticathode.* By Messrs. Buguet and Chabaud. A communication to the French Academy, describing a method of cooling the terminal in a Crookes tube by means of a circulation of water or mercury. 2 cols.—*Comptes Rendus*, Oct. 16th, 1899.

Rotary Converters.—*The Design of Rotary Converters.* By H. F. Parshall, M. Inst. C.E., and H. M. Hobart, S.B. This article continues a previous contribution on the subject. 2½ cols.—*Engng.*, Dec. 22nd, 1899.

Self-Induction.—*The Influence of Self-Induction upon the Rate of Interruption of the Wehnelt Interrupter.* By Ernst Ruhmer. Comments on Dr. Simon's theory, and reference to the author's experiments. 3 cols.—*Elektrotechn. Zeitschrft.*, Nov. 9th, 1899.

Signalling.—*The Sullivan Galvanometer.* The article describes the apparatus and its working which enables a commander in war-time to establish communication through submarine cables. 1¼ cols.—*Elec. Rev.* (London), Nov. 3rd, 1899.

Transformers.—*Iron Loss—Its Increase—The Remedy.* By J. W. Nubley. "The necessity of inspection, testing, etc., of all meters in service at regular periods, has been conceded as an economic necessity by central stations, yet such has not been true about transformers, and this important and essential apparatus has been most seriously neglected, owing to the impression and erroneously accepted fact, that its characteristics are, in a measure, unchangeable. It is, however, a generally accepted fact that there comes a time in the history of transformers when their efficiency and profit-earning can be greatly increased by means of substitution or change of characteristics." It is the latter plan that the writer treats in this article. 4½ cols.—*Electricity*, December 29th. 1899.

—— *A new Type of Transformer.* Abstract of an article by Mr. C. P. Feldmann, contributed to the *Elektrotechnische Zeitschrift*, describing a new type of transformer constructed by the Helios Company, of Cologne. This latest type has been in the market about 12 months, during which time it has been adopted by a number of central stations, an aggregate output of 5,000 kw. being already installed. (Ill.). 1¾ cols.—*Elec. Engr.*, Dec. 29th, 1899.

Welding.—*Electric Welding and Metal Working.* By Herrmann Lemp. Article describing the apparatus and methods employed by Prof. Elihu-Thomson. 6 cols.—*Elektrochem. Ztschrft.*, Nov. 1899.

MARINE ENGINEERING AND SHIPBUILDING.

Atlantic Liner.—*The North-German Lloyd and its great double-screw steamer "Kaiser Wilhelm der Grosse."* Full and detailed description of the greatest Atlantic liner. (Ill.). 10½ cols.—*Dingler's Polyt. Journ.*, Jan. 5th, 1900.

Cable Ships.—*The New Cable Ship "von Podbielski."* Description of a cable-ship owned by Germany, recently launched at Port Glasgow. 3 cols.—*Elect'n.* (London), Nov. 17th, 1899.

Carrying Appliances.—*Overhead Cranes, Staying and Riveter Carrying Appliances in the Shipyard.* James Dickie. Detailed description of the apparatus. (Ill.). 3 cols.—*Soc. of Nav. Archts. and Marine Engrs.*, Nov. 1899.

Electrical Equipment.—*The Electrical Equipment of the Largest Ship Afloat.* Account of the electric lighting machinery, the electric motors and the telephone system on the steamship *Oceanic*. 3 cols.—*Am. Elect'n.*, Nov. 1899.

Launching.—*Launching Ships' Boats.* Abstract of a paper by John Hyslop, read before the American Society of Naval Architects and Engineers. The author, a gentleman well known in naval affairs, deprecated the fact that little or no improvement had been made in this matter for 50 years. He recommended the principle of the Mallory davit and suggests some improvements. 1½ cols.—*Engng.*, Dec. 15th, 1899.

Lighthouses.—*A Circular Steel Light-Tower at Sturgeon Bay Canal, Wisconsin.* Account of a new type of lighthouse possessing the advantages of simplicity, economy and durability. 1 col.—*Engng. News*, Nov. 9th, 1899.

—— *Methods of Revolving the Optical Apparatus for Lighthouses.* D. P. Heap. Description of machinery. 2½ cols.—*Scient. Am.*, Nov. 25th, 1899.

Merchant Marine.—*Our Merchant Marine upon the Oceans.* By George F. Edmunds. Article discussing the question of increasing the foreign

trade of the United States and of putting the carrying trade in the hands of American vessels. 3 cols.—*Marine Rev.*, Nov. 2nd, 1899.

Metal Coatings.—*Experiments upon the Durability of Different Metal Coatings immersed in Water.* By Prof. A. H. Sabin. Abstract of a paper read before the American Society of Civil Engineers. The tests were made under the following conditions: One set of plates was exposed in salt water at the Brooklyn Navy Yard, another set was exposed under fresh water at Lake Cochitnate, and a third was exposed under salt water at the Norfolk Navy Yard. All of the plates were placed in water during the last half of June, 1897. The Norfolk and Cochitnate plates were removed from the water in July 1899, after two years' exposure, but those in the New York waters were in cages suspended to a float which was accidentally sunk in July 1898, and more than half of the plates were lost. The remaining plates were removed on 21st July, 1898, after an immersion of exactly 13 months. 4 cols.—*Industr. and Iron*, Jan. 12th, 1900.

Pilot Yacht.—*The Humber Steam Pilot Yacht, "Commander Cawley."* Description of a steam yacht which was recently handed over to her owners the Humber Pilots, by her builders, Messrs. J. T. Ettringham & Co., of South Shields. (Ill.). 1½ cols.—*Engng.*, Dec. 29th, 1899.

Rudders.—*On the Action of the Rudder, with Special Reference to the Motion of the Ship while the helm is being put over.* Wm. F. Durand. Account of experimental investigation, accompanied by data. 8 cols.—*Sec. of Nav. Archts. & Marine Engrs.*, Nov. 1899.

Shipbuilding.—*Shipbuilding and Marine Engineering in* 1899. Article giving full details and statistics of the subject. The total vessels floated during the past year make up a total of 1,753,757 tons, which exceeds by 82,000 tons the total of 1898. 5⅝ cols.—*Engng.*, Dec. 29th, 1899.

Shipyard Tools.—*New Shipyard Tools by Messrs. Craig and Donald, Johnstone.* The article illustrates and describes some of the most recent designs and shipyard tools constructed by Messrs. Craig & Donald, engineers, Johnstone, near Glasgow, amongst them a powerful set of plate bending rolls of novel design, a seven-roller plate-flattening machine, a powerful double-ended beam or angle-iron bending or straightening machine for shipyard work, &c. (Ill.). 1 col.—*The Steamship*, Jan. 1900.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, and Fuel.

Boiler-Heating.—*Experiments on using Gasoline Gas for Boiler-heating.* Abstract of a paper by Herman Poole, read at the annual meeting of the American Society of Mechanical Engineers at New York. The author describes some experiments made at Philadelphia with a 60 horse-power boiler in order to ascertain whether gasoline could be used to get up steam in a boiler and at what cost. The results showed that steam could be raised, but at a cost much higher than that of coal. 5 cols.—*Electricity* (New York), Dec. 20th, 1899.

Boilers and Engines.—*The Improvement and Development of Boilers and Steam Engines.* By Thomas Begrie. Abstract of a paper read before the Mech. Engrs. Assoc., Johannesburg. 3 cols.—*Ir. & Coal Trade Rev.*, Nov. 3rd, 1899.

—— *Apparatus for the Automatic reconducting of the condensed water into the Boilers.* By C. Hoffman. The author describes the construction and working of an apparatus which renders very economical results. (Ill.). 1¾ cols.—*Text. Ztg.*, Dec. 18th, 1899.

Boiler Shops.—*The Boiler Works of the Alsatian Company for Machine Construction at Grafinstaden.* Description of a modern boiler works owning many electrically operated tools and hydraulic riveting machinery. 6 cols.—*Ztschrft. d. Ver. Deutsch. Ing.*, Oct. 7th, 1899.

Combustion.—*Combustion and Forced Draught.* Abstract of a paper read before the Birmingham Association of Mechanical Engineers, Nov. 4th, 1899, by Mr. R. B. Hodgson, A.M.I.Mech.E. (To be continued.) 5½ cols.—*Mech. Engr.*, Dec. 30th, 1899.

Fuel.—*A new Automobile Fuel—Electrolytic Alcohol.* Dr. George H. Benjamin, of New York, recently returned from Russia, draws attention to the growing use of alcohol as a fuel for explosion-motors in that country. This liquid—almost absolute ethyl-alcohol—can be produced by the Villon electrolytic process for about 8 cents a gallon. The article describes the method of manufacture of this alcohol and its use in automobiles. 3½ cols.—*Elec. Rev.* (New York), Dec. 13th, 1899.

—— *Advantages of Coke over Coal as a Fuel for Generating Steam.* Arthur C. Freeman. Abstract of a paper read at Montreal, at the meeting of the New England Cotton Mfrs'. Assoc. 1½ cols.—*Am. Mfr. and Ir. Wld.*, Nov. 9th, 1899.

Furnace.—*Furnace Efficiency.* By A. Bement. The article deals with the conditions of combustion in boiler furnaces, and the determination of its efficiency by gas analysis, showing a substantial relation between the efficiency and the percentage of carbon dioxide present. 5½ cols.—*Power* (New York), Dec. 1899.

Mechanical Draft.—*The Substitution of Mechanical Draft for Chimney Draft.* By R. Schenkel. Description of numerous devices for producing mechanical draft in steam-boiler plants, chiefly taken from American practice. (Ill.). 9 cols.—*Zeitschrft. d. Ver. Deutsch. Ing.*, Oct. 14th, 1899

Smoke Consumption.—*The Limits of Economy in Smoke Consumption.* Investigation of the thermal conditions of smoke consumption, including gas-firing and the use of pulverised fuel. 4 cols.—*Gesundheits Ing.*, Nov. 15th, 1899.

Smoke Nuisance.—*Practical Smoke Prevention.* B. W. Nicholson, Smoke Inspector, Sheffield. This article continues a series of contributions by the same author, and deals with an automatic stoker, called the "Helix Furnace Feeder," which supplies the fresh fuel underneath instead of at the top of the fire. (Ill.). 3 cols.—*San. Rec.*, Dec. 15th, 1899.

Superheating.—*The Application of Superheated Steam.* By H. Hoff. Description of the mechanical devices of superheaters of modern types. 3 cols.—*Ztschrft. d. Ver. Deutsch. Ing.*, Oct. 28th, 1899.

2. Compressed Air.

Air Compressors.—*The Intercooler in the Air Compressor.* Frank Richards. The author dwells on the value and efficiency of the intercooler, adding suggestions for the increase of this efficiency. (Ill.). 1⅞ cols.—*Am. Mach.*, Nov. 9th, 1899.

Compressed Air.—*Compressed Air.* J. J. Swann. Account of the production, transmission, and use of compressed air.—*Sib. Journ. of Engng.*, Nov. 1899.

3. Engines and Motors.

Automobiles.—*Acetylene Motor Wagons and Carriages.* Description of a victoria and the running gear of a standard truck for delivery wagons, operated by acetylene gas. ⅔ col.—*Scient Am.* Nov. 11th, 1899.

Automobiles.—*Automobiles and their Future in Italy.* Giuseppe Spera. Abstract of a report of the Commissioner of Public Works, discussing the influence of the automobile upon the improvement of public highways and the possible competition with railways. 4 cols. — *Rivista Gen. delle Ferrovie*, Oct. 29th, 1899.

—— *Motor Vehicles in the Stock Market.* Editorial comments considering the four kinds of motive power used, and reviewing the standing of the automobile industry. 4 cols.—*Eng. News*, Nov. 2nd, 1899.

—— *A short Account of some Modern Steam Wagons.* By George A. Burls. Abstract of a paper read before the Civil and Mech. Engrs.' Soc. General comments on the efficiency, durability, power, and speed of these vehicles. 9 cols.—*Automotor Jour.*, Nov. 1899.

—— *The Common Automobile Systems.* By Prof. H. Bachner, Stuttgart. The present article is the beginning of a series of contributions in which the author fully describes the more common classes of automobiles. He begins with the benzine-motors, of which he gives a detailed account. (Ill.). 3½ cols.—*Dingler's Polyt. Journ.*, Jan. 5th, 1900.

—— *The Progress of Motor Vehicles.* By W. N. Fitzgerald, of New York. Abstract of a paper read at the meeting of the National Carriage Builders' Association at Indianapolis. 3½ cols.—*Coach Bldrs'. and Wheelwrights' Art Journ.*, Jan. 1st, 1900.

—— *A Record Making Automobile.* Description of a vehicle built by the Electric Vehicle Company, U.S.A., which lately obtained the world's record for electric automobiles. The data obtained were: Total distance travelled, 100 miles; total time consumed, 7 h. 45 min.; average speed in miles per hours, total time, 13'9; total kilowatt hours expended, 13'6; total kilowatt hours of charge, 20'9; cost of charge at six cents per kilowatt hour $1.25; cost per mile 1¼c. (Ill.). 2½ cols. —*Elec. World and Engr.* (New York), Dec. 23rd, 1899.

—— *An Account of Some Modern Steam Wagons.* A paper read before the Civil and Mechanical Engineers' Society, Nov. 2nd, 1899. 8 cols.—*Mech. Engr.*, Dec. 23rd, 1899.

Engines.—*The Turner-Pegg Corliss Gear.* While it is generally conceded that excellent results have been obtained, in point of steam economy, from engines fitted with Corliss gear, it has long been recognized that the somewhat complex trip gear necessary represents a feature which in view of its initial cost and liability to derangement should be dispensed with if at all possible. With this end in view, engines have been designed both in England and America, in which trip gear is altogether abandoned. The article describes the latest departure in this direction. (Ill.). 1½ cols.—*Mech. World*, Jan. 5th, 1900.

—— *The Steam Engine at the End of the Nineteenth Century.* Abstract of a paper by R. H. Thurston, presented at a meeting of the Am. Soc. of Mech. Engineers. (To be continued.) 3¾ cols. —*Mech. World*, Jan. 5th, 1900.

—— *The Erection of a Three Thousand Horse-Power Horizontal Engine.* Description of the installation of a great direct connected electric light engine at Sixty-sixth Street Station of the Brooklyn Edison Company, which was accompanied by some difficulties. 2½ cols.—*Power* (New York), Dec. 1899.

Excavation.—*A Novel Power Excavator.* The article gives a detailed description of a steam excavator recently patented by Mr. Harvey C. Lowrie, which contains some novel and practical features that render it adaptable to a wide range of conditions. Although primarily designed as a trenching machine, it is suited for other kinds of excavation. (Ill.). 2¾ cols.—*Mech. Engr.*, Dec. 30th, 1899.

Fly-Wheel.—*A Broken Fly-wheel and how it was repaired.*—By James McBride. Detailed description of the repairing which was carried out with a minimum of loss of time. (Ill.), 1¾ cols.—*Mech. World*, Dec. 22nd, 1899.

Gas Engines.—*An Efficiency Test of a One-Hundred and Twenty-five Horse-Power Gas-Engine.* By E. H. Robertson. Description of the plant of the Merchants' Electric Lighting Co. of Lafayette, Ind., with data concerning the power of the engines. 10 cols.—*Trans. Am. Soc. Mech. Engrs.*, Dec. 1899.

—— *An Efficiency Test of a One-Hundred and Twenty-five Horse-Power Gas-Engine.* The data are given very fully, and the article gives a clear description of the engines used and the manner of their installation. (Ill.). 15½ cols.—*Power* (New York), Dec. 1899.

—— *Utilization of High-Furnace Gases for Power in Gas-Engines.* By Bryan Donkin, M. Inst. C.E. No. III. The article illustrates and describes experiments made by Prof. Meyer, in Oct. 1898, with a 60 horse-power Otto 4-cycle motor at the Differdingen Ironworks in Luxemburg. (Ill.). 2 cols.—*Engr.*, Dec. 15th, 1899.

Turbines.—*Parsons' Steam-Turbine.* Description of the device mainly compiled from *Engineering*. (Ill.). 3½ cols.—*Dingler's Polyt. Jour.*, Jan. 5th, 1900.

4. Power and Transmission.

Dumping.—*The O'Rourke Dumping-Bucket.* Description of a recently-patented drop-bottom bucket. 1¼ col.—*R. R. Gaz.*, Nov. 24th, 1899.

Horse-Power.—*On the Value of a Horse-Power.* Abstract of a paper by George J. Rockwood, M.E., read before the Am. Soc. of Mech. Eng., describing an interesting litigation recently concluded in Massachusetts, arising from the diversion by the city of Worcester of water from the head waters of the Blackstone river. Owners of privileges on the river sued for damages on account of the impairment of their power. The question was whether they should be reimbursed on a basis making good their loss, or at so much per horse-power, considering the latter as a commodity, and fixing its market value at the price usually paid by a willing buyer to a willing seller. 8½ cols.—*Power* (New York), Dec. 1899.

Lifting.—*Lifting a 24-Ton Girder Four Storeys.* Description of a difficult manipulation successfully accomplished at night-time. 1½ col.—*Engng. Rev.*, Nov. 11th, 1899.

Pedal-Power.—*The Power Transmitted by a Pedal.* Abstract of an article in *l'Industrie Vélocipédique et Automobile*, giving experiments and results. 2 cols.—*Automotor Journ.*, Nov., 1899.

Power.—*The Power Plant of the Paris Exposition.* The article describes the arrangement of the engines, boilers, and generators in the main power plant, and the subterranean distribution of steam and water mains. The illustrations give a plan and elevation of the plant, with details of the piping arrangements. (Ill.). 3 cols.—*Power* (New York), Dec, 1899.

Transport Appliances.—*Mechanical Transport Appliances in Engineering Work.* By A. J. S. B. Little. Summary review of the means that greatly reduce the cost of engineering undertakings together with recommendations for the increase of their use. (Ill.). 7 cols.—*Engng. Mag.*, Dec., 1899.

Water-Power Plant.—*Jacques-Cartier Water-Power Plant.* A new electrical power-plant of a highly interesting nature is in course of construction at St. Gabriel, P. A., Canada, and utilizes a fall of 30 feet only in the St. Gabriel River for producing a current that will be transmitted to Quebec, 18 miles distant, at 20,000 volts, to be

there applied to lighting and power purposes. The article gives details of construction and working. (Ill.). 1½ col.—*West. Electr.*, Dec. 9th, 1899.

5. Machine Works, Shop and Foundry.

Cranes.—*Cranes, Travellers, and other Hoisting Machinery, XV.* (conclusion).—The article, which concludes a series of contributions on the subject, deals with miscellaneous hoisting machinery. 2¾ cols.—*Railw. Engr.*, Jan. 1900.

Drilling Machine.—*An Automatic Variable-feed Driller.* The article describes a drilling machine with a feed that is not only automatic, but, which at a given point, automatically increases to four times its normal rate, and then changes back again and proceeds until the piece of work is done, when it automatically releases. It is built by Baker Brothers, Toledo, Ohio, U.S.A. (Ill.). 1½ col.—*Am. Mach.*, Dec. 14th, 1899.

Hardness of Metals.—*Tests for Hardness.* Description of an apparatus devised by Prof. Unwin for the purpose of testing the hardness of metals by means of an indenting tool of hard steel, having the form of a knife edge. 1½ col.—*Mech. Engr.*, Dec. 23rd, 1899.

Indicator.—*The Trabor Indicator.* Description of a simple and economical indicator. (Ill.) 2½ cols. *Text. Merc.*, Dec. 30th, 1899.

Machine Appliances.—*Prof. Ripper's Mean-Pressure Indicator.* Article giving a short outline of a novel instrument invented by Prof. Ripper, and described by him in a paper read before a meeting of the Institution of Mechanical Engineers. (Ill.). 3½ cols.—*Mech. Engr.*

Planing.—*A much extended Planer Tool.* By Oberlin Smith. It is a common experience with all machinists running a planer, that the nose, or horizontal part of the ordinary tool carrying the cutting edge at its front end, will not reach far enough forward to extend into apert res in the work of any considerable depth. To meet such cases certain tools are forged with long noses until the same become too springy to be consistent with a due degree of usefulness. The author, therefore, contrived a special tool with a nose of about 8 ft. long, which he describes in detail. (Ill.). 2 cols.—*Am. Mach.*, Dec. 21st, 1899.

Planimeter.—*The Lippincott Planimeter.* By Prof. A. G. Greenhill. The article describes an improved planimeter, a modification of the Hine-Robertson planimeter, invented by Mr. A. C. Lippincott, with the object of performing the more exte ded class of work required now of a planimeter. The price is about £3, and the new instrument is obtainable through Elliott Brothers, of St. Martin's Lane, W.C. (Ill.). 3½ cols.—*Engr.*, Dec. 22nd, 1899.

Machine Shops.—*Shops of Baker Brothers, Toledo, Ohio, U.S.A.* Description of a model machine shop installation of moderate size. (Ill.) 3 cols.—*Am. Mach.*, Dec. 14th, 1899.

Machine Tools.—*Cold Sawing Machines by Messrs. Clifton and Wadell*, machine tool makers, Johnstone, near Glasgow. The article illustrates and describes two types of cold sawing machines for cutting forgings or castings of iron, steel, etc. (Ill.) 1 col.—*The Steamship*, Jan. 1900.

—— *British and American Machine Tools No. IV. Their Comparative Cost.* (Continued.) The author sums up in saying that the American machine tool maker has generally the advantage over his English rival on the following points:—1. Economy of trade expenses; 2. the purchasing of material; 3. the production of castings; 4. the more extended use of special machinery and appliances; 5. the time saved by keeping his machines continually employed on one class of work; (6) a greater number of working hours per week; 7. The comparative freedom from trades unionism. (Ill.). 2 cols.—*Engr.*, Dec. 15th, 1899.

Machine Tools.—*The Work of Machine Tools.* Abstract of a paper contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, describing the investigations of Messrs. F. Hillier and Ch. Frémont. 2½ cols.—*Engr.* (London), Nov. 17th, 1899.

Milling Machine.—*Vertical Profile Milling Machine, with Combined Flat and Circular Table.* Description of a milling machine constructed by Messrs. Greenwood & Batley, Albion Works, Leeds. The machine is one that is distinguished both by efficiency of design and handiness of manipulation, and a large field presents itself for its use in general engineering work, while it is especially applicable for milling the end of connecting rods for locomotives or other engines. 1 col.—*Mech. Engr.*, Jan. 6th, 1900.

Screw Machine.—*Automatic Screw Machine.* Description of a machine for producing all kinds of pins, collar studs, washers, bushings or turned work, and being specially adapted also for the production of projectiles. 2 cols.—*Engng.*, Nov. 10th, 1899.

Spinning Appliances.—*The Roving Frame.* By Clement J. Charnock, Sereda, Russia (continued.) 3½ cols. (Illus.).—*Text. Recdr.*, Dec. 15th, 1899.

6. Miscellaneous.

Boiler Compounds.—*The use of Boiler Compounds.* By Albert A. Cary. The author examines the various compounds recommended for preventing the troubles due to the formation of scale. 8½ cols.—*Am. Mach.*, December 7th, 1899.

Chains.—*The Testing of Chains.* The article mentions the usual methods of testing, and describes several practical machines constructed for the purpose. (Ill.). 3 cols.—*The Mech. Engr.*, Dec. 23rd, 1899.

Chimney.—*Monumental Chimney of the La Bourdonnais Power-House.* C. Lenguy. Description of the great chimney power-house of the Paris Exposition. (Ill.). 5 cols.—*Revue Technique*, Oct. 25th, 1899.

Dividing Engines.—*The Wurdemann Automatic Dividing Engine.* C. L. Berger. Description of apparatus for automatically graduating the circles of astronomical and scientific instruments. This apparatus contains various novel features and is distinguished by the highest accuracy. 1½ cols.—*Engng. News*, Nov. 2nd, 1899.

Hydrostatic Pressure.—*High Hydrostatic Pressures and their Application to Compressing Liquids.* By Francis H. Stillman. Description of a new form of pressure gauge. (Ill.). 4 cols.—*Trans. Am. Soc. of Mech. Engrs.*, Dec. 1899.

Machine Tools.—*American Machine Tools for English Works.* By an American Engineer. The author describes a radial drilling machine and a vertical turret boring and turning machine made by the Niles Tool Works Company, of Hamilton, U.S.A., now being supplied to English works. (Ill.). 2½ cols.—*Engr.*, Dec. 15th, 1899.

Milling.—*Elements of Milling Science.* III. An article continuing previous contributions on the subject of milling and its methods. 2 cols.—*The Miller*, Jan. 1st, 1900.

Modern Machine Shops.—*The U.S. Machinery Building at the Paris Exposition.* Article describing a building to be constructed in the park of Vincennes on recently acquired territory by the U.S. Government, representing a typical modern American machine shop. (Ill.). 1¾ cols.—*Engng. Rec.* (New York), Dec. 16th, 1899.

Photo-Printing.—*Modern Photo-Printing Processes.* By Herman Esser. The author describes the three best known processes in actual use: The so-called blue or negative process, giving white lines on blue blackground; the nigrosene or positive black process, or the maduro or brown process. 2½ cols.—*Engng. News* (New York), Dec. 7th, 1899.

Printing Machinery. — *The "Bridgewater" Feeder.* The article describes the construction and work of an automatic feeder for printing machines patented by Mr. Bridgewater of Leicester. One of these feeders is now at work in the printing office of Mr. Edward Shardlow of that town. (Ill.). 2¾ cols.—*Brit. and Colon. Print. and Statr.*, Dec. 21st, 1899.

Reloading Cartridge Shells.—*A Tool for Reloading empty cartridge shells.* The article describes a very simple and ingenious tool for reloading empty cartridge shells, patented by Walter H. Gripman, of Sioux Falls, South Dacota. U.S.A. By means of this tool the old primer is rapidly expelled, a new primer accurately inserted, the shell and bullet resized, the mouth of the cartridge expanded, and the bullet securely fastened in the charged shell (Ill.). 1 col.—*Scient. Am.*, Dec. 16th, 1899.

Rolling Mills.—*Should Break Rolls be Sharp?* By W. T. Bates. The author declares that the present system has existed about 20 years, and will attain its majority with the beginning of the century; but that it will not go far into the next century in its present form, but be permanently superseded by an improved method. 3 cols.—*The Miller*, Jan. 1st, 1900.

—— *Further development of Roller Flour Milling.* The article begins a series of papers by W. R. Voller on the subject, starting with an examination of the component parts of a roller plant. 2 cols.—*The Miller*, Jan. 1st, 1900.

Telescopes.—*The Great Paris Telescope.* By Norman Lockyer. The article contains a detailed description of the enormous telescope to be constructed on the occasion of the Paris Exhibition of 1900. This telescope is to be a refractor mounted in front of a siderostat. The details are taken from communications sent to the author by "Le Conseil d'Administration de la Société Optique," and from the "Annuaire du Bureau des Longitudes." (Ill.). 5 cols.—*Nature*, Dec. 21st, 1899.

MINING AND METALLURGY.

1. Coal and Coke.

Coal Mining.—*The Ignition of Fire-damp and Coal-dust by means of Electricity.* Abstract of an interesting paper recording the experiments of Bergassessor Heise and Dr. Theim. 2¾ cols.—*Coll. Guard.*, Jan. 12th, 1900.

—— *Winning Thin Seams in the Dortmund Coalfield.* Translation of an article in *Glückauf.* 2 cols.—*Coll. Guard.*, Jan. 12th, 1900.

—— *On the Determination of Volatile Combustible Matter in Coke and Anthracite Coal.* By Richard K. Meade and James C. Attix. 2¾ cols.—*Industr. and Iron*, Jan. 12th, 1900.

—— *The Combustibility of Coals.* By O. Lang, in *Glückauf.* This article gives a summary in English of the German article. The latter draws attention to the publications of Prof. Fischer, of Goettingen, on the subject, but adds that sufficient light has not yet been thrown upon the question, even in Germany, and regrets that there are no more such works as Muck's "Steinkohlenchemie" ("Chemistry of Mineral Coal"). 1½ col.—*Am. Mfctrer.*, Dec. 17th, 1899.

—— *Coal in Servia.* By E. Hegner and J. François. Abstract of a report to the "Société des Ingénieurs des Mines du Hainau," describing the coal deposits and the mining processes. 1 col.—*Coll. Guard.*, Nov. 17th, 1899.

—— *The Coal Fields in South Africa.*—Description of the Natal Navigation Collieries. (To be continued.) 1 col.—*Iron and Coal Trds. Rev.*, Oct. 27th, 1899.

—— *Electricity in Coal Mining.*— By John Price Jackson and Frank F. Thompson. Description of lighting, haulage, cutting, drilling, pumping, etc., by electricity in soft coal mining. 8 cols.—*Trans. Am. Inst. of Elec. Engrs.*, Oct., 1899.

—— *Improved Methods of bringing down Coal in Prussia.*—Translated extracts of an article in *Glückauf*, describing blasting by rock-boring, explosives, igniters, etc. 1½ col.—*Coll. Guard.*, Nov. 3rd, 1899.

—— *Improved Methods of bringing down Coal in Prussia.*—(Continued.) Translated extracts of an article in *Glückauf.* 1½ col. —*Coll. Guard.*, Nov. 3rd, 1899.

Coke Handling.—*The Mechanical Handling of Coke.* By J. Laveretiere. Description of methods of handling coke in gas-works practised in the United States and in France. 4 cols.—*Génie Civil*, Oct. 14th, 1899.

Coke Quenching.—*A Dry Quenching Process for Coke.* Description of Method. ¾ col.—*Ir. and Coal Trds. Rev.*, Nov. 3rd, 1899.

Coke.—*The Automatic Quenching and Loading of Coke.* Description of a novel form of conveyor for coke-ovens, designed by Mr. Joseph Müller, of the Mathias Colliery at Essen, in Germany which takes hold of the coke as it comes from the ovens in a red-hot state, at once quenches it with water, raises it out of the water, allows it to dry, discharges it on a sieve or grate, and finally loads it into wagons or stows it in boats, in one continuous automatic operation. ¾ col.—*Ir. and Coal Trds. Rev.*, Dec. 22nd, 1899.

Northumberland. — *The Northumberland Coal Field.* Description of Linton Colliery, situated two-and-a-quarter miles north of Ashington station, on the Blyth and Tyne section of the North-Eastern Railway, and nine miles north-east of the shipping port of Blyth. 1½ col.—*Coll. Guard.*, Jan. 12th, 1900.

Prospecting.—*Prospecting for Coal in Colorado.* Arthur Lakes. Hints for distinguishing the geological formation in which coal may be found. (Ill.). *Mines and Min.*, Nov. 1899.

Separation.—*The Separation of Coal and other Light Minerals.* By Walter J May. Account of water separation and the employment of jigging machines. 2 cols.—*Coll. Guard.*, Oct. 27th, 1899.

Trusts.—*The Greatest European Trust.* The article deals with the Coal Syndicate of Westphalia, to which nearly all the coal-mining societies of that district belong, and which controls an annual output of more than 50 millions of tons. 6 cols.—*L'Echo des Mines et de la Métallurgie*, Jan. 11th, 1900.

2. Copper.

Refining.—*The Electrolytic Refining of Copper at Anaconda, Montana.* E. C. Sickles. Outline of the method employed. 3 cols.—*Sib. Journ. of Engng.*, Nov. 1899.

Solutions.—*Copper Tubes and Sheets direct from Solutions.* Outline of this method of refining copper and the products obtained. 1 col.—*Min. and Scient. Press*, Nov. 18th, 1899.

3. Gold, Silver, and Diamonds.

Battery Frame.—*The "A" Battery Frame for Stamp Mills.* By Robert W. Barrell. Description of the manner of construction of this battery frame and its advantages. 1½ cols.—*Mines and Min.*, Nov. 1899.

Cyanide Plant.—*Method at the Taylor Mine Cyanide Plant, El Dorado County, Cal.* By E. F. Gropello. Detailed account of the plant and the working. (Ill.). 1½ cols.—*Min. and Sc. Press*, Oct. 28th, 1899

Deep Mining.—*The Emerson Shaft of the Wildman Mine, Sutter Creek, Cal.* Description of a plant specially adapted for deep mining (Ill.). 1 col.—*Min. and Sc. Press*, Nov. 18th, 1899.

Diamond-Mining.—*The Parent Rock of the South African Diamond.* By T. G. Bonney. Abstract of a paper on the subject read before the Royal Society. 3 cols.—*Nature*, Oct. 21st, 1899.

Diamond Mining.—*Diamond Drilling.* By H. M. Lane. Means of recovery of test rods, bits, and diamonds, and methods of obtaining cores from soft or soluble material. 2 cols.—*Mines and Min.*, Nov. 1899.

Gold Mining.—*De la Mar's Mercur Mines, Utah.* II. The Ore Treatment. By H. L. J. Warren. The article describes in detail the several reductions of the ore by calcining, roasting and leaching until the tailings, freed from gold, are dumped outside the mill. (Ill.). 2½ cols.—*Engng. & Ming. Journ.*, Dec. 30th, 1899.

—— *The Vanderbilt Mining District, San Bernardino County, Cal.* Description of the district and its interesting vein system. 1¾ col.—*Min. & Sci. Press*, Nov. 18th, 1899.

Placer Mining.—*A Low-Grade Placer Proposition in Montana.* By Fred. D. Smith. Description of a placer which is worked, though yielding less than 2c. per yard. 2½ cols.—*Engng. & Min. Journ.*, Nov. 11th, 1899.

Ore Deposits.—*Description of Raven Hill, Cripple Creek and its Ore Deposits.* Arthur Lakes. Description of the vein in the Elkton mine. 1¾ col.—*Mines & Min.*, Nov. 1899.

Proof.—*Proof Gold and Silver.* By Mr. Cabell Whitehead. The author describes in detail the methods of preparing pure gold and silver in use at the mints, which is to be used as "proof" or standard for comparison. 1¼ col.—*Engng. and Mining Journ.*, Dec. 30th, 1899.

Sampling.—*Some Notes on Mine Surface Sampling.* By S. H. Pearce. A discussion of the processes employed and the obstacles to be overcome. 10 cols.—*Journ. Chem. & Met. Soc. of S. Africa*, Aug. 1899.

Silver Ores.—*The Treatment of the Dry Silver Ores in South America.* By A. A. Watson. Description of methods employed in Chili, Peru, and Bolivia. 4 cols.—*B. C. Min. Rev.*, Nov. 1899.

4. Iron and Steel.

Blast Furnaces.—*The Iron Making Blast Furnaces as an Ideal Power Producer.* Horace Allen. (To be continued). Account of the utilisation of blast furnace gases. 1 col.—*Am. Mfr. and Iron Wld.*, Nov. 9th, 1899.

Blast Heating.—*The Brotherton Blast Heater.* Description of a method of heating blast by utilizing the heat of the slag from the furnace, devised by Mr. Tidney E. Brotherton, and for some time past used by him in the works under his charge at Silver City, New Mexico. ¾ col.—*Ir. and Coal Tr. Rev.*, Dec. 22nd, 1899.

Cast Iron.—*Physical Characteristics of Malleable Cast Iron.* By Erastus C. Wheeler. Account of influence of heat, chemical composition, annealing test bars, &c. 2⅔ cols.—*Ir. Age*, Nov. 9th, 1899.

Colour Scale. *Colours of Heated Steel corresponding to Different Degrees of Temperatures.* By Maunsel White and F. W. Taylor. Hints on the value of the colour scale to those engaged in steel works. ½ col.—*Trans. Am. Soc. of Mech. Engrs.*, Dec. 1899.

Condensing Plants.—*Central Condensing Plants for Iron Works.* Abstract from Journal West of Scotland Iron and Steel Institute. The article discusses the conditions under which central condensing plants are operated, and the difficulties that have to be surmounted. (Ill.). 2 cols.—*Am. Mftrer.*, Dec. 14th, 1899.

Critical Ranges.—*The Critical Ranges in Iron and Steel.* By H. M. Howe. 3 cols.—*Metallographist*, Oct. 1899.

Iron and Steel Industries.—*The Iron and Steel Industries of Germany in* 1899. By R. M. Daelen (Düsseldorf). Article dealing with the efforts made in Germany during the previous year. 3½ cols.—*Ir. and Coal Trade Rev.*, Dec. 29th, 1899.

Iron Foundry.—*Uehling's Foundry Machine.* Full description of Uehling's device for the founding and loading of iron. (Ill.). 5½ cols.—*Stahl u. Eisen*, Jan. 1st, 1900.

Iron Industry.—*The German Iron Industry in the year* 1899. By Emil Schroedter. The author demonstrates that last year has been an exceedingly prosperous one for the iron industry in Germany. 3 cols.—*Ir. and Coal Trade Rev.*, Dec. 29th, 1899.

Iron Mines.—*Spain's Resources in Iron Ores.* Article commenting on the rumour that the famous iron mines at Bilbao are approaching exhaustion, and pointing out that in Spain, especially in the South, there are a great many more deposits of great richness, and that at the end of last year the aggregate of exportable iron ores amounted to 1,305,000,000 tons. 1 col.—*L'Echo des Mines et de la Métallurgie*, Jan. 11th, 1900.

—— *The Mahoning Iron Mines.* Description of this mine and its operation. (Ill.). 1¾ cols.—*Ir. Age*, Nov. 9th, 1899.

Iron Ore.—*Cuban Iron Ore.* Editorial on the project of establishing an extensive iron and steel plant at Boston, for the working of ores from Cuba and Spain. 2½ cols.—*Engr.*, Nov. 17th, 1899.

Iron Works.—*Sixty years in Iron Works.* Presidential address by George Beard, delivered to the West of Scotland Iron and Steel Inst., discussing various features of interest concerning iron works. 6 cols.—*Ir. and St. Trds Journ.*, Oct. 28th, 1899.

Microscopic Analysis. — *Practical Microscopic Analysis for use in Steel Works.* By C. H Ridsdale. Abstract of a paper read before the Iron and Steel Inst. of Great Britain, dwelling on the usefulness of the microscope for iron and steel works. 9 cols.—*Engng. News*, Nov. 2nd, 1899.

Nickel Steel.—*Nickel Steel and its Uses.* Abstract of a paper, by R. A. Hadfield, read before the Inst. of Civ. Engrs., describing various applications of nickel steel. 3½ cols.—*Ir. and Coal Trds. Rev.*, Nov. 17th, 1899.

—— *The Age of Nickel Steel.* By Harry J. Williams. Account of the armour-plate tests in 1890, and the effects on nickel steel, demonstrating its advantages. 2 cols.—*Ir. Age*, Nov. 9th, 1899.

Open Hearth Process.—*The Use of a Large Proportion of Soft Pig Iron in the Open Hearth Process.* By A. Sattman. Full description of a novel basic open-hearth process to be used continuously in direct connection with the blast furnace. 9 cols.—*Stahl u. Eisen*, Oct. 15th, 1899.

Testing.—*Forge and Shop Tests of Iron and Steel.* By W. C. Popplewell. 2½ cols.—*Mech. Engr.*, Dec. 30th, 1899.

Transport.—*Economy in the Transport of Raw Material for Iron Manufacture.* Lecture by Mr. E. Schrödter, dealing with the general transport facilities in Germany. 22 cols.—*Stahl u. Eisen*, Jan. 1st, 1900.

Steel Works.—*The new Industrial Development of Japan and the Imperial Japanese Steel-works.* The article is richly illustrated and contains a detailed description of the magnificent plant of steel-works, situated in Yawatamura, near Wakamatsu, a port known as export port for coal. The plans for the installation of furnaces were drafted at the Technical Bureau of Mr. Fritz W. Lürmann, in Osnabrück, and the iron structures, &c., were executed at the Gutehoffnungshütte, in Oberhausen, Germany. 9½ cols.—*Stahl u. Eisen*, Dec. 15th, 1899.

5. Mining.

Accidents. — *Fatal Accidents in Mines and Quarries during* 1899. Abstract of the Home Office return showing the number of fatal accidents and deaths in and about the mines of the United Kingdom during the year 1899. ½ col.—*Coll. Guard.*, Jan. 12th, 1900.

Blasting. — *Blasting in Mines.* Translation of portions of an article in the *Allgemeine bergmännische Zeitschrift*, dealing with the choice of explosives, the placing of the charges, the igniters, &c. 2 cols.—*Coll. Guard.*, Nov. 17th, 1899.

Compass.—*The Langer Compass Suspension for Use in the Neighbourhood of Iron.* By H. Brathuhn. Description of a method of suspension for a mining compass by which the relative deflection due to neighbouring masses of iron may be determined. 3 cols.—*Oest. Zeitschrft. f. Berg u. Hüttenwesen*, Oct. 28th, 1899.

Deep Mines.—*Mining at Great Depths.* Account of great depths already reached in mining and projected mines in the Witwatersrand. 1 col.—*Engr.*, Nov. 3rd, 1899.

Dynamite.—*Conditions for Safely Storing Dynamite in Underground Workings.* Summary of a report by M. H. Le Chatelier to the "Commission des Substances Explosives," published in the *Annales des Mines*, containing an account of experiments to ascertain the most advantageous conditions. (Ill.). 2 cols.—*Coll. Guard.*, Oct. 27th, 1899.

Fire-damp.—*Apparent Cause of Error in Fire-damp Determination by the Limits of Inflammability.* M. Lebreton. Extracts from an article in the *Annales des Mines*, discussing the causes of variation. 1 col.—*Coll. Guard.*, Nov. 3rd, 1899.

High Explosives.—*New Home Office Test for High Explosives.* Account of a special test proposed in order to assist miners in selecting safe explosives. 1¼ cols.—*Ir. and Coal Trds. Rev.*, Nov. 17th, 1899.

Mine Tubs. — *Automatic Tubs for Mines.* The article, summarized from a contribution to *Glückauf*, shows a side elevation and plan of an automatic stop for preventing mine tubs from running down an incline before such descent is intended. This arrangement has been patented by Mr. Hirtz, underground manager, and Mr. Peisen Overmann, of Mariadorf, Rhenish Prussia. ½ col.—*Coll. Guard.*, Jan. 12th, 1900.

Mining Laws.—*The Field Mining Law.* A new group of mining regulations that became effective in the State of Washington, United States, on June 9th, 1899. 1¾ cols.—*Mines and Min.*, Nov. 1899.

Oil Boring.—*Boring for Gas and Petroleum in China.* From the *Petroleum Industrial and Technical Review.* Account of the methods used and their working. 1¼ cols.—*Sci. Am. Sup.*, Nov. 18th, 1899.

Ore Deposits.—*An Examination of Ore Deposits at Rammelsburg, near Goslar.* By Dr. Söhle. Description of copper, lead, and sulphur ore deposits in Hanover. (Ill.). 7 cols.—*Oester. Ztschrft. f. Berg u. Hüttenwesen*, Nov. 11th, 1899.

Peat.—*Peat Fuel.* Article fully dealing with the subject of peat as fuel, of which the United Kingdom possesses about six millions of acres that are at present practically worthless, but may become of great value when the high price of coal renders it necessary to search for cheaper burning material, as peat gives just as good results as coal, and in many cases, superior. 2½ cols.—*Ir. and Steel Trades Journ.*, Jan. 6th, 1900.

Prospecting. — *The Florissant Basin.* Arthur Lakes. Narrative of a prospecting excursion in the volcanic region between Cripple Creek and South Park. 2½ cols.—*Mines and Min.*, Nov. 1899.

Resine Work.—*Resine Work in Mines.* Translation of portions of an article by Hugo Rössner in the *Oesterre chische Zeitschrift für Berg und Hüttenwesen*, describing the drill in the use of the apparatus and appliances. 1¼ cols.—*Coll. Guard.*, Nov. 3rd, 1899.

Rope Haulage.—*Rope Haulage in Mines.* Description of the endless rope system and of the main and tail. 1½ cols.—*Engng. and Min. Journ.*, Nov. 25th, 1899.

—— *The Rope Haulage Plant of the Coke Ovens at the Röckling Steel Works at Voelklingen on the Saar, in Altenwald.* By H. Weihe. Full description of the plant with illustrations showing the arrangement of the cables, etc. 5 cols.—*Glückauf*, Oct. 14th, 1899.

Safety Lamps.—*A New Safety Lamp Lock.* By M. H. Banguiet. Description of three systems investigated on account of an explosion, caused by opening the lamp. The author recommends the Bornal lock with a lead rivet. 2¼ cols.—*Coll. Guard.*, Nov. 17th, 1899.

—— *Improved Süssmann Lamp at the Strepy-Bracquegnies Collieries.* By Joseph Goffin. A description of the lamp accompanied by illustrations. 1 col.—*Coll Guard.*, Nov. 10th, 1899.

Shaft Sinking.—*Sinking a Shaft in the Bois du Lue Collieries.* Translation of portions of an article by Adolphe Demeure in the *Annales des Mines de Belgique*, describing the working of certain improvements introduced to facilitate operations. 3 cols.—*Ir. and Coal Trds. Rev.*, Nov. 17th, 1899.

Storing.—*Appliances for Handling and Storing Coal and Iron-Ore.* By M. Buhle. Description of various designs of conveyors and other devices for handling used on the continent, in England and in the United States. (To be continued.) 6 cols.—*Zeitschrft. d. Ver. Deutsch. Ing.*, Oct. 14th, 1899.

Tin Mining.—*Lode Tin Mining in the Malay Peninsula.* Abstract of a paper by W. H. Derrick, read before the Institution of Mining and Metallurgy, in London. The author describes in detail the conditions and results of mining in the only vein mine in the Malay Peninsula. 1¾ cols.—*Engng. and Min. Journ.*, Dec. 30th, 1899.

Ventilators. — *Comparative Experiments with Capell and Mortier Ventilators at the Bonifacius Mine.* Both ventilators were driven by electricity and the article describes the tests in detail, giving tables of results accompanied by diagrams. 8 cols.—*Glückauf*, Oct. 28th, 1899.

Winding Engine. — *The Compound Winding Engine, its Operation and Steam Consumption.* By Julius Divis. Account of the advantages of the compound engine for mine hoists, and of the methods employed for computing cylinders, ratios, etc. (To be continued.) 5 cols.—*Oester. Zeitschrft. f. Berg u. Hüttenwesen*, Nov. 4th, 1899.

Westralia. — *Westralian Mines in* 1899. The author tries to show that, though to judge from the fall in the prices of Westralian gold shares during the closing quarter of the year, the progress of the colonial industry seemed to have been disappointing, improved results of a very gratifying character have to be recorded. 4½ cols.—*Min. World and Engng. Rec.*, Jan. 13th, 1900.

6. Miscellaneous.

Alloys.—*Concerning Alloys.* An account of recent progress of knowledge of the nature of alloys, and the manner in which metals combine when fused together. 7 cols.—*Stahl u. Eisen*, Oct. 15th, 1899.

Coal.—*Artificial Coal in Germany* The U.S. Vice-Consul at Mannheim reports that he has recently assisted at a trial to demonstrate the combustible properties of an artificial coal invented in Germany. The inventor claims all sorts of earth

may be used for his substitute, except sand gravel. Certain ingredients, which are the inventor's secret, are mixed with the earth and worked into a homogeneous mass for the purpose of making it inflammable. It is stated that 50 kilogrammes (110 lbs.) of the artificial coal will not cost more than 3½d. to produce. 1 col.—*Journ. of the Soc. of Arts*, Jan. 12th, 1900.

Corundum.—*Notes on the Corundum-Bearing Rocks of Eastern Ontario, Canada.* By Willet G. Miller. Description of the ore deposits. 3 cols.—*Am. Geol.*, Nov. 1899.

Graphite.—*Graphite.* By J. Ohly. Article describing its occurrence and properties. (To be continued.) 1½ col.—*Min. Rptr.*, Nov. 2nd, 1899.

Manganese. — *The Manganese Industry in Southern Russia.* By F. W. Lürmann. Summary of the output of the various works, giving statistics for the period from 1893 to 1898. 4 cols.—*Stahl u. Eisen*, Oct. 15th, 1899.

Mining Camp.—*The Republic Mining Camp, Washington.* By M. H. Joseph. Historical record and description of the camp. (Ill.). 3½ cols. *Engng. and Min. Jour.*, Nov. 25th, 1899.

Mica.—*The Occurrence and Uses of Mica.* By M. L. Fuller. Short history of the mining of this mineral, and description of its deposits and its uses. 3 cols.—*Stone*, Nov., 1899.

—— *Microstructure of Alloys.*—By J. E. Stead. Account of the microstructure of alloys of antimony and tin, antimony and copper, and copper and tin. (Ill.). 12 cols.—*Metallographist*, Oct., 1899.

Rhodesia.—*Rhodesia: Now and Then.* An article giving a sanguine forecast regarding the prosperous future of Rhodesia. 1¾ col.—*Min. Wrld. and Engng. Rec.*, Jan. 13th, 1900.

Rubies.—*On a New Mode of Occurrence of Ruby in North Carolina.* By J. W. Judd and W. E. Hidden. Description of recent discoveries in the State of North Carolina. (Ill.). 7 cols.—*Am. Jour. of Sci.*, Nov., 1899.

Sulphide Ores.—*Has the Sulphide Problem been Solved?* Note stating that a process has been discovered to treat successfully with the sulphide ores that are found below those of the oxidised class in the mines of Western Australia. ½ col.—*Min. Wld. and Engng. Rec.*, Jan. 13th, 1900.

Wire.—*Recent Progress in Wire Manufacture.* Interesting article giving a short history of the ancient art of manufacture of wire and of modern methods. (Ill.). 3½ cols.—*Ir. and Coal Trades Rev.*, Dec. 22nd, 1899.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Acetylene.—*The Action of Acetylene on the Oxides of Copper.* By F. A. Gooch and De Forest Baldwin. Describing the results of special experiments. 3 cols. *Am. Journ. of Sci.*, Nov. 1899.

—— *The 1899 Acetylene Congress at Nürnberg.* Account of the Congress and summary of the more important papers. 2½ cols.—*Engr.*, Nov. 17th, 1899.

—— *The Purification of Acetylene by Means of Chloride of Lime.* The article deals with the necessity of purifying the gas, and describes the methods employed. 2½ cols.—*Engr.*, Nov. 3rd, 1899.

Benzol.—*Estimation of Benzol in Illuminating Gas.* Summary in translation of an article by Otto Pfeiffer in the *Journal für Gasbeleuchtung*. Description of various methods. 3 cols.—*Gas Wld.*, Nov. 4th, 1899.

Gas Explosion.—*Explosion at Manchester Corporation Gas Works.* Account of an explosion which resulted in the death of the manager and severe injuries of various persons. 5 cols.—*Gas Wld.*, Nov. 4th, 1899.

Gas Meters.—*Gas Supply by Automatic Meters.* Abstract of a paper by H. O. Eldridge, read at a meeting of the So. Dist. Assoc. of Gas Engrs. and Mngrs., England, describing the results obtained at Tottenham. 6 cols.—*Gas Wld.*, Nov. 11th, 1899.

Gas Light.—*The Return to Gas in Street Lighting of a Municipality.* By Mr. E. H. Yorke, of Portland, Me. The article explains why the city of Portland, Me., U.S.A., after an experience of 15 years with electric street lighting has returned to the use of gas. 1½ col. *The Gas World*, December 23rd, 1899.

Gas Supply.—*Gas Supply in Germany—The Crefeld Works.* The article dwells on the great progress made of recent years in Germany, regarding gas manufacture, and selects as an example the progress made in one German gas-works, of which a most exhaustive annual report has just come to hand, namely that at Crefeld, a town of about 108,000 inhabitants in the Rhine Provinces of Prussia. 2½ cols.—*Journ. of Gas Lighting and Water Supply*, Jan. 2nd, 1900.

Gas Works.— *The Municipal Gas and Water Works at Halle on Saale.* Description of the construction and operation of the plant. (Ill.). 5½ cols.—*Gesundh. Ing.*, Oct. 31st, 1899.

—— *The Gas Works at Ponu, Puerto Rico.* By D. L. Hough. Short history of the gas plant in Puerto Rico. 5 cols.—*Am. Gas Light Journ.*, Nov. 13th, 1899.

—— *The New Gas Works of the City of Zürich et Schlieren.* By A. Weiss. (To be continued.) A full description of the plant erected in a suburb of Zürich. 4 cols.—*Schweiz Banstg.*, Oct. 28th, 1899.

Governors.—*Notes on the Working of a Self-Loading Governor.* W. Whatmough. Abstract of a paper read before the Manchester Dist. Inst. of Gas Engs., giving a description of the Heywood Gas Works. 2½ cols.—*Gas Engrs. Mag.*, Nov. 10th, 1899.

Illumination.—*Interior Illumination.* Abstract of a paper by Mr. F. N. Morton, read before the Am. Gas Light Co.s. The author comes to the conclusion that illumination by means of a uniformly illuminated ceiling by lights shielded from view is the most satisfactory from a hygenic point of view, but by no means economical; in fact, hygiene and economy are in their interests at present entirely opposed. 4½ cols.—*The Gas World*, Dec. 9th, 1899.

Lighting.—*Public Lighting by Gas and Electricity.* By W. J. Dibbin, late Chemist and Superintending Gas Examiner to the Metropolitan Board of Works and the London County Council. The article deals with various kinds of Photometers. (To be continued.) 2½ cols.—*Sun. Rec.*, Dec. 15th, 1899.

Retorts.—*Inclined Retorts.* Abstract of a paper by B. W. Smith, read before the Midland Assoc. of Gas Magrs., describing the working of the inclined retorts at the Smethwick Gas Works. 4 cols.—*Gas Wld.*, Oct. 28th, 1899.

Stoking.— *Automatic Stoking for Gas Works* Although Automatic Stoking has been so extensively adopted for firing of ordinary steam boilers, it is only within recent years that the application of labour-saving devices of this kind has been introduced into gas works. The article describes the installation recently completed at the gas works at Leigh, in Lancashire, and gives full details of the appliances for automatic stoking. (Ill.). 2 cols.—*Mech. Engr.*, Jan. 6th, 1900.

Water-Gas.—*The Deltwich Water-Gas Process.* By Dr. G. Lunge. Translation of the author's contribution to the *Journal für Gas-beleuchtung* in the *Progressive Age*. The article shows that scientific investigation confirms the views of the discoverer, namely, that it is practicable to produce

by means of the Dellwick process more than double the amount of water-gas that was formerly held to be possible from the same quantity of fuel, and that this can be accomplished in the "blowing up" by burning the carbon, not to carbon monoxide but to carbon dioxide. 5½ cols.—*The Gas World*, Dec. 23rd, 1899.

Water Gas.—*Carburetted Water Gas as a Coal Gas Auxiliary.* Abstract of a paper by A. G. Glasgow, read before the Am. Gas Light Association. Account of gas works adapted for this double method of production, and hints for computing the result from a comparison of either system separately. 3 cols.—*Am. Gas Light Journ.*, Nov. 13th, 1899.

2. Sewerage.

Sewage Disposal.—*Chemical Precipitation and Rapid Filtration of Sewage at Madison, Wis.* Formerly a system of sewage existed discharging the crude sewage into the Mendota and Monona Lakes. With the natural increase of the population of the town (now about 18,000), and the number of sewer connections, there began to be complaints regarding the pollution of the lakes. The American Sanitary Engineering Co. of Detroit, Mich., presented plans for chemical precipitation tanks and filter beds. The article deals with the working of this method, which was adopted by the town. (Ill.). 8 cols.—*Engng. News.* Dec. 28th, 1899.

—— *Recent Lawrence Experiments in Sewage Disposal.* Summary of annual report of the Massachusetts, State Board of Health for 1898, by H. W. Clarke, chemist in charge of the Lawrence experiment station. The report relates to the studies of the septic-tank and bacteria-bed methods of sewage disposal. 5 cols.—*Engng. Rec.*, Dec. 23rd, 1899.

—— *Sewage Disposal at Lincoln, England.* The article contains a description of the sewage disposal in use at Lincoln. The works were designed by Mr. James Mansergh, and have been in operation for many years. 5 cols.—*Engng. Rec.*, Dec. 23rd, 1899.

—— *The Septic Tank at Overbrook, N. J., U.S.A.* Abstract from a paper by Mr. James Owen Montclair, read at the recent convention of the New Jersey State Sanitary Association and dealing with the treatment of sewage by natural processes. The method is illustrated by a description of a small plant for the Essex county asylum. 2 cols.—*Engng. Rec.* (New York), Dec. 16th, 1899.

—— *Sewage Disposal Experiments at Leeds.*—Account of experiments with sewage bacterial processes, chemical treatment, and land filtration. 1 col.—*Engng. Rec.*, Nov. 4th, 1899.

—— *Sewage and Purification.* By Dr. S. Rideal. Abstract of the fifth lecture on the subject by the author at the University College, Gower Street, London, W.C., which deals with the chemical changes produced by bacteria. 2½ cols.—*San. Rec.*, Dec. 15th, 1899.

—— *The Moon Island Sewage Reservoir at Boston.* Description of the new basins built to hold the sewage until the tide arrives at the proper point to effect its discharge into the sea. 1½ cols.—*Engng. Rev.*, Nov. 7th, 1899.

—— *The Sewerage of Walsall, England.* The article gives a full description of a disposal system with chemical treatment, supplemented by land filtration, and also of a peculiar dredge for cleaning the sewers. 2½ cols.—*Engng. Rev.*, Nov. 18th, 1899.

—— *Sewage Disposal at Aldershot.* Article describing the results obtained with the double bed bacteria-system. 1 col.—*Engng. Rev.*, Nov. 29th. 1899.

—— *The Use of Coke in the Treatment of Sewage.* Summary of the report of Frank Clowes on the bacterial treatment of sewage, with an account of the experiments made with the crude sewage of London in the coke-beds at Crossness. 5 cols. —*Journ. Gas Lghtg.*, Oct. 24th, 1899.

3. Streets and Pavement.

Paving.—*Brick Paving in Several Cities.* By L. M. Hastings. Abstract of a paper read before the Am. Soc. of Munic. Imp. The article deals with the manufacture, qualities, durability, etc. of bricks for paving. 4½ cols.—*Munic. Engng.*, Nov. 1899.

—— *The Life of Pavements.* George W. Tillson. Abstract of a paper read before the Soc. of Munic. Imp., commenting on the conditions on which the life of city pavements depends. 8 cols.—*Munic. Engng.*, Nov. 1899.

4. Water Supply.

Aqueduct.—*Completing the abandoned Aqueduct Tunnel at Washington, D.C.* After having been abandoned for about 10 years, the work of completing the Washington aqueduct tunnel was resumed by the U.S. Government in 1898. The article gives a description of the work carried on at present. (Ill.). 2½ cols.—*Engng. News*, Dec. 28th, 1899.

Water Pipes.—*The Incrustation of Iron Pipes.* The diminution in the carrying capacity of water mains, caused by incrustations, often becomes a serious matter. The article describes the decrease in the capacity of the mains of Torquay, England, and the method employed for removing the incrustations. (Ill.). 7½ cols.—*Engng. Rev.*, Dec. 30th, 1899.

Water-Supply.—*Test of two Ten-Million Gallon Pumping Engines at St. Louis, Mo., U.S.A.* Abstract from a paper by Mr. John A. Laird, of St. Louis, read at the meeting of the American Society of Mechanical Engineers. The author describes the test, remarkable in view of the high economy shown by the engine, the feed water consumed being 11·65 lbs. per indicated h.-p. per hour. The duty attained by each engine was over 160,000,000 foot-lbs. per thousand lbs. of feed water. (Ill.). 4 cols.—*Engng. Rev.* (New York), Dec. 16th, 1899.

Water Rates.—*Water Rates in the Large Cities of the United States.* Abstract of a paper by Mr. August Herrman, read before the Am. Soc. of Munic. Imp., comprising the water rates of 31 cities. 4 cols.—*Mun. Engng.*, Nov. 1899.

Waterworks.—*The Dresden Waterworks.* By James H. Fuertes, M. Am. Soc. C. E. (Ill.). 2 cols.—*Engng. Rev.*, Dec. 30th, 1899.

—— *The Outlet-Valves at the Burrator Reservoir, Plymouth.* Mr. E. Sandeman, water engineer of the Plymouth Corporation, in a paper read before the Institution of Mechanical Engineers at that town, first gives an outline of the history of the waterworks which date back to 1585, and then describes the Burrator reservoir and its pipe line. It is situated on the western slope of Dartmoor, and contains 651 million gallons; the top water-level being 708 feet above the sea. (Ill.). 1½ cols.—*Journ. of Gas Lighting and Water Supply*, Jan. 2nd, 1900.

—— *The Merthyr Tydfil Waterworks.* Abstract from a paper by Mr. T. F. Harvey, engineer and surveyor to the Merthyr District Council, describing the installation. 2½ cols.—*Journ. of Gas Lighting*, Dec. 26th, 1899.

5. Miscellaneous.

Disinfecting.—*The Disinfecting Station at Zürich* By James H. Fuertes. Description of the municipal station and its equipment. 1 col.—*Engng. Rev.*, Nov. 11th, 1899.

REVIEWS OF BOOKS . . .

RECENT BOOKS.

Steam Engine Theory and Practice. By William Ripper, M.Inst.C.E., M.I.M.E., etc. Longmans, Green & Co., London, 1899.

In its most improved form, the steam engine has reached so high a standard of excellence that little further development can be expected from the designer. This satisfactory state of things has the effect of rendering sound knowledge more than ever necessary to the modern student of steam engineering. Some treatises on the subject are hopelessly out of date, and few sufficiently illustrate the nature of modern refinements by the aid of which theoretical conceptions have been so closely approached in actual practice.

Prof. Ripper has written a book in which special attention is directed to the subject of the heat quantities involved in the generation and use of steam. The temperature-entropy chart of Capt. Sankey appears for the first time in this book, with several important additions made since its preparation in 1889. Lines of constant pressure and volume and scales of total heat and internal energy are now included as well as the chart for the superheated steam field. In explaining the application of the temperature-entropy diagrams, the author mentions the fact that "of the total heat supplied to steam engines, from 2 to 10 per cent. may be converted into useful work in non-condensing engines, and in multiple expansion condensing engines the percentage may be raised as high as 20 per cent. or more." The remainder of the heat is lost by condensation in the cylinder, by radiation, and by the amount carried away in the exhaust. This loss of heat to exhaust, he says, "may be best understood by a careful study of the temperature-entropy chart, from which it will be seen how the proportion of exhaust waste may be most effectively reduced." A number of cases are then considered illustrating the relation between the total heat added and the heat rejected to exhaust. The author proceeds to discuss the functions and details of the slide valve and of the indicator, and then goes on to describe various methods for the increase of efficiency of steam in the cylinder. Appliances such as injectors, condensers, feed-water heaters, and governors are next selected for treatment, after which mechanical problems and details are discussed, not exhaustively perhaps, but sufficiently for the objects in view. The chapter on engine balancing throws no fresh light on the difficulties of a problem, in connection with reciprocating engines, which has hitherto escaped solution, and to which more attention might with advantage be devoted by engine builders. The volume is concluded by detailed accounts of some essentially modern types of engines, in which we are pleased to find the author has made use of the latest sources of available information. His work may justly be regarded as a valuable contribution to the technicological literature of the day.

Commercial Africa in 1899. Treasury Department, Bureau of Statistics, U.S. Government, Washington, W.C.

Nothing better illustrates the determination of the United States to become the future world's exporting power than the multitude of reports, papers, statistics and general information concerning the trade of foreign countries, which have been issuing in such profusion under American official, semi-official, and private auspices, during the past two years. These are not occupied with one country; they concern the whole globe. The indefatigable U.S. Consuls are incessant in their exertions in pointing out to their manufacturers the directions in which American export trade may be profitably developed. And American trade *is* developing, and at a rate that is calculated to produce in the minds of British manufacturers and exporters the most serious reflections.

The volume we have before us is a State publication, yet it contains no signs of red-tape, being indeed, a complete *vade mecum* to commercial Africa. It deals with Africa in order of Colonies. Statistics are given of the import and export trade of the various trade districts, whilst a multitude of commercial "tips"—there is no better word—are interspersed with the descriptions of the natural features and resources of each. Throughout the whole of this volume, British commercial predominance throughout practically the whole of Eastern Africa, from North to South, is plainly visible. How long this predominance will continue to exist under the Free Trade system by which we throw open fields we have won to our competitors is a difficult question.

NEW CATALOGUES.

The Editor will be pleased to supply copies of any catalogue noticed.

Electric Generators—Electric Motors—Lightning Arresters.—The British Westinghouse Electric and Manufacturing Company, Ltd., Westinghouse Building, Norfolk Street, W.C. We have received a number of sectional catalogues recently issued by the British Westinghouse Electric and Manufacturing Company, Ltd., relating to dynamos, electric motors and lightning arresters. These books are more in the nature of treatises than catalogues, the theoretical principles of the plant dealt with being lucidly explained, and illustrated with general views and sectional drawings.

Electric Light Engines.—Browett, Lindley and Co., Ltd., Patricroft, Manchester. We have been much struck at the great typographical advance evident in the trade literature of to-day over that of only a few years ago. The catalogue of Messrs. Browett, Lindley & Co.'s well-known electric light engines, well bears out this character of advance in its tasteful get-up and handsome printing. Messrs. Browett, Lindley & Co.'s vertical steam engines with their valuable self-lubricating system, are getting more and more in favour for steady-running and economy. The catalogue describes various types of steam engines, ranging up to 500 brake horse-power.